VOL. 2 OCTOBER • 1945 NO. 4

THE FOCAL SPOT

Roentgen Anniversary Number

JOURNAL OF THE CANADIAN SOCIETY OF RADIOLOGICAL TECHNICIANS

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News Items from the Provinces

ALBERTA SOCIETY OF RADIOLOGICAL TECHNICIANS

EDMONTON BRANCH

The first meeting of our Society was held on September 18th. Correspondence was read from our Provincial President, which cleared up a lot of questions that had been hanging fire.

Membership here is on the increase, and interest in the Society is steadily growing. Arrangements were made for a study group for students wishing to write the Fall examinations, and these are to be held Tuesday and Friday of each week. Any rural members who are in town for any of these meetings are cordially welcomed.

The group here were sorry to hear that lapel pins were dropped for the time being. Many of the girls who are writing their exams are either married to fellows in the service, or engaged to service men, and they would like a souvenir to wear after they have quit. For these and several other similar cases the decision on lapel pins was rather unfortunate, and decision of group was that we should try and see if some reconsideration of this matter could be brought about.

Our sympathies to Miss E. Swail who is sick in the hospital, and our hopes for a speedy recovery.

Welcoming back of Bob Murphy following his illness, and the decision that in future elections two members of four-member Executive would be appointed each year and two would resign, gives us an Executive with members serving a two year term, and guarantees change of officers.

CALGARY BRANCH

The Fall sessions were opened September 10th with a social evening at the home of Miss Shaw at Midnapore.

It had been intended to hold this in the open as a corn roast, but due to the inclement weather we had to adjourn inside. However, after the business meeting we still had the corn roast, and spent a most enjoyable evening, thanks to our hostess.

Mr. John Welch was welcomed home on his discharge from the Navy.

Congratulations were given to four of our members—S/Sgt. Beatty, Miss MacNeill, Mrs. Yerex and Miss Gall—on passing the Dominion Society examinations.

A nominating committee was formed to bring in a slate of officers for the Calgary Society for 1946.

In reference to the next examinations, it is presumed that they will be held in November. Will those members intending to write please send their applications in to the Provincial Secretary as early as possible.

As this issue of The Focal Spot will be the last for 1945, will all our members please bear in mind that membership fees will fall due on January 1st, 1946.

On September 24th we had a visit from Mr. Frank Dreisinger. Though we had only a short time to notify our members a good number turned out to have dinner with him, and then adjourned to the Belcher Hospital when he gave us a most interesting and instructive talk, and all felt well repaid for making the effort to meet him.

We are happy to know that Dr. W. S. Quint is recovering from his recent operation in Toronto. Now that he is back in "Sunny Alberta" we hope to soon have him around again.

Our Provincial President, Mr. Welch, during a recent hurried visit to Vancouver, had the pleasure of meeting with the Executive of the B.C. Society, and discussing Dominion Society matters with them.

Mrs. Yerex is leaving the staff of the Belcher Hospital, and her place is being taken by Mr. John L. Welch. We wonder if there is any other x-ray department where father and son are working together.

Will our members please note that we have no articles on hand for The Focal Spot. Let us have several before the next issue.

HERBERT M. WELCH,
President.

(continued on page 164)

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News Items from the Provinces

BRITISH COLUMBIA SOCIETY OF X-RAY TECHNICIANS

On Friday, September 28th, a special meeting of the B.C. Society was held in Shaughnessy Hospital in order to give our members an opportunity to meet Mr. Frank Dreisinger of the Picker X-Ray Corporation. This was a very enjoyable and instructive meeting. Mr. Dreisinger proved to be a very able speaker and his descriptions of techniques and positions proved of great assistance to the large number who attended the meeting. Many questions were asked and Mr. Dreisinger was able to clear up a lot of puzzling points. All members voted it to be the best meeting we have held for some time. A very hearty vote of thanks was extended to Mr. Dreisinger by the President. Refreshments were served afterwards to make a very pleasing finale to a meeting that will long be remembered by all our members.

The first meeting of the Winter season will be held in St. Paul's Hospital on Thursday, October 11th, 1945.

Mr. Bert Welch, President of the Alberta Society, paid a short visit to Vancouver and arrangements were made to have him meet our Executive. This proved to be a very enjoyable occasion and was a great help to us. Mr. Welch's advice was of great value in helping us to realize just how much good we can all get from the Society. After a long and interesting meeting Mr. Welch entertained the Executive to tea.

We hope to have a good representation at the first meeting of the winter and arrangements have been made to have one of our Radiologists address the meeting. At later meetings we intend to have X-Ray Physics explained by one of our members. I would like to draw this to the attention of the Student Members as it will be very helpful and give them valuable information preparatory to sitting for their certificates.

The November meeting will be Nomination night and the election will be held at the December meeting. Help us keep the organization vigorous by attending these important meetings. Remember an organization is only as strong as its officers and it is up to every one to see that a strong slate is elected.

No engagements or marriages have been reported, so all seems to be quiet in the heart department.

Mr. Walter Miller has returned from overseas service and is now on the staff of Shaughnessy Hospital.

I have been asked by the Executive to draw attention to the list of B.C. Members who are overseas. The following corrections should be made:

Cpl. H. Barclay, Overseas.
S/Sgt. G. Enoch, Little Mt. Camp, Vancouver.
Lieut. N/S. H. W. French with U.S. Forces.
Sgt. J. Gibson, Overseas.
Sgt. M. O'Donaghy, Overseas.
Pte. N. Thompson, Overseas.
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Sgt. C. Beckett, Vancouver Military Hospital.
Cpl. J. Baird, University of B.C.
Pte. H. Tait, Vancouver Military Hospital.

W. Q. STIRLING,
President.

MANITOBA SOCIETY OF X-RAY TECHNICIANS

It is with great regret that we learn of the untimely passing of Mr. Bodle's youngest daughter, Sally, at Victoria Beach in August. We all extend our deepest sympathy to Mr. and Mrs. Bodle.

The fall meetings commence October 12th, at which our official delegate to the Annual Convention in Montreal will give his report. We are anxious to hear the news and points of interest of the meeting and to see some slides and snaps.

We have the pleasure of accepting four successful candidates to our Society, who wrote the May examinations.

We are looking forward to having our members of the armed services with us again in the near future. With their many experiences they must have plenty of interesting things to tell us.

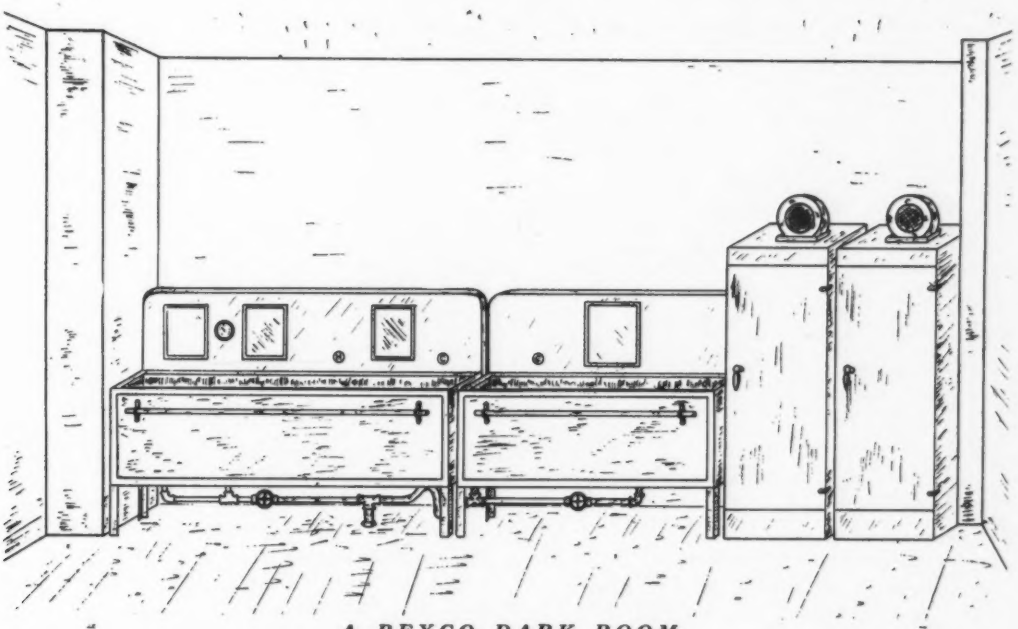
Congratulations are in order for Mr. and Mrs. Orin Vermilyea on the birth of a son. Both parents are members of our Society.

ALICE GRAY,
President.

"It is very agreeable to have a broad knowledge, and it sometimes is useful, but after all it is only activity that brings real satisfaction."—ROENTGEN.

(continued on page 221)

The Modern Darkroom



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Medical Clinic, 710 Seymour St., Vancouver, B.C.

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103 Medical Arts Bldg., Winnipeg.

Secretary: Miss Mary Hallam,
118 Medical Arts Bldg., Winnipeg.

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We regret that due to pressure on our space in this special issue it was impossible to print the conclusion of the Verbatim Minutes of the Third Dominion Convention. This will be published in the January number.

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1945 - 46

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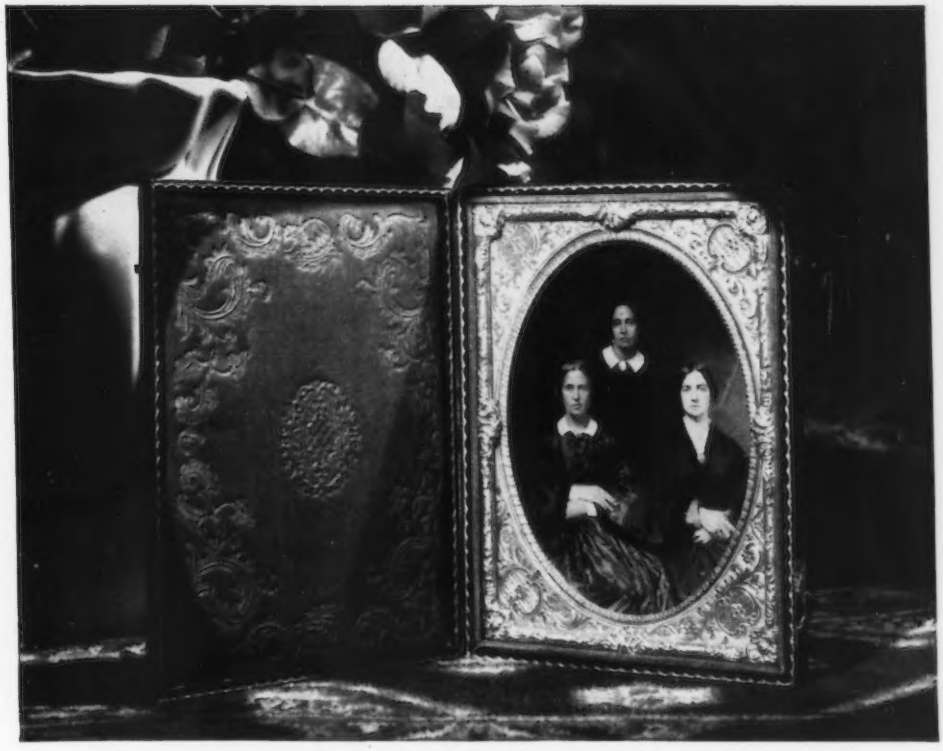

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The Focal Spot

Journal of the Canadian Society of Radiological Technicians

Volume 2 TORONTO, ONTARIO, OCTOBER, 1945 No. 4

"All our ambitions should be devoted to a faithful fulfilment of duties towards others as well as to ourselves."—Roentgen.

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EDITORIAL

Fifty years ago, early in November, 1895, Wilhelm Conrad Roentgen discovered "a new kind of ray". By a coincidence the present year of grace is also the hundredth anniversary of the birth of the discoverer of the x-rays.

The effect of the utilization of these "magic rays" during the past fifty years is staggering to the imagination, so widespread are its ramifications.

This was a discovery from which the discoverer neither desired nor received any financial benefit and he presented it to mankind to develop as it pleased.

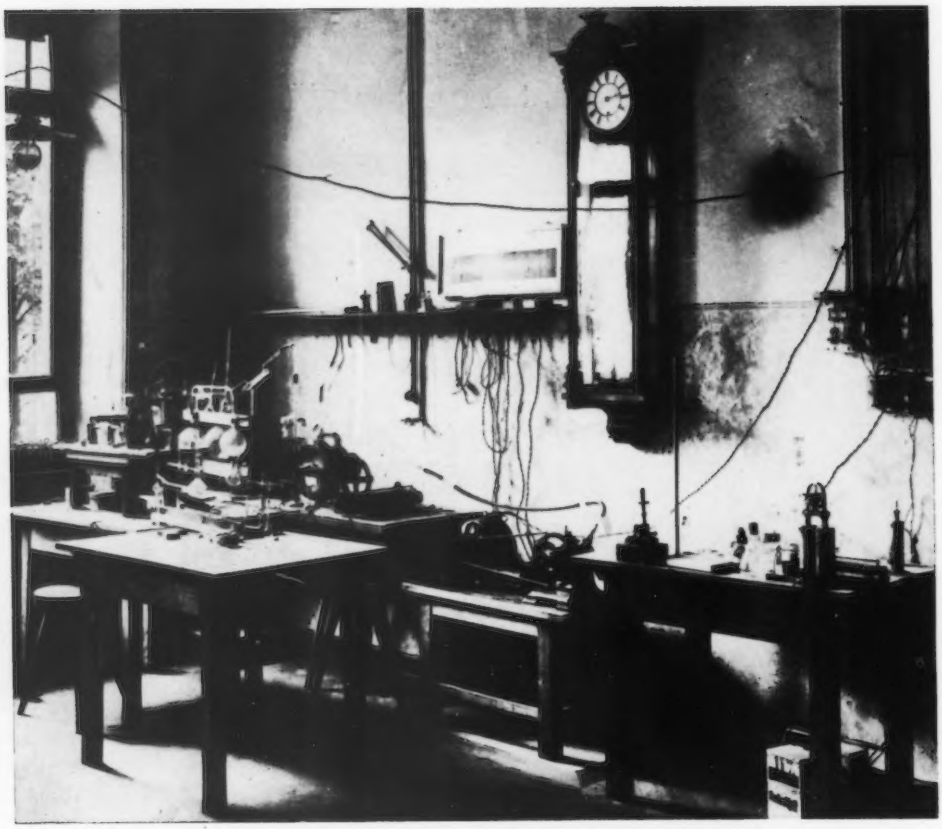
The story of the subsequent development of equipment for producing and utilizing x-rays would fill volumes. In this special commemorative number of The Focal Spot we have attempted to render our small tribute to the discoverer and to sketch the circumstances leading up to the event, together with the more recent improvements and developments, and a description of the highest peak of achievement to date, the successful production of a unit in which a million volts pass through the tube.

It would be interesting and does not call for too much imagination to visualize what the future may hold; in fact we have a foretaste of it in the article in this issue on a photo-electric timing device. It also seems probable that film will eventually be developed dry by a gas.

The vast advances in apparatus should make technicians very conscious of the increased power for good work placed in their hands and should make even more evident the necessity for improving their technique by the interchange of ideas afforded by a Society such as ours. It is also to be hoped that as the Society becomes stronger it will find ways and means of helping, perhaps by moving pictures or lecture tours, those in small centres of population, who have not always all the facilities in the way of modern equipment which we in the cities have available.

Roentgen Ray Semi-Centennial

1895



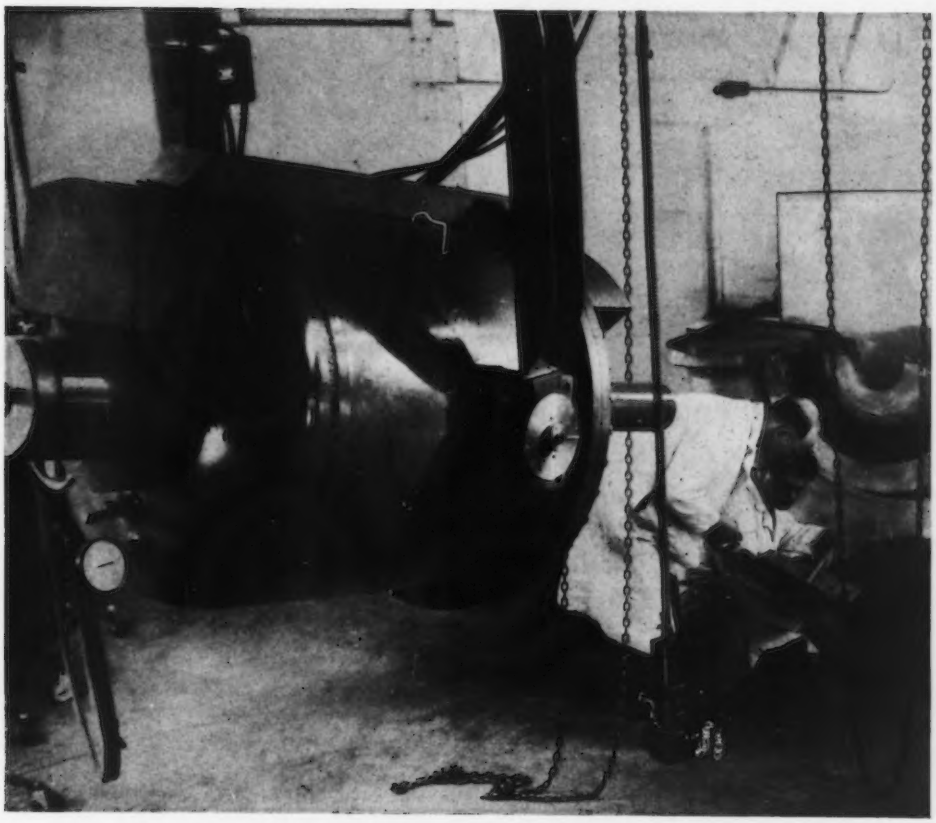
INTERIOR OF ROENTGEN'S LABORATORY IN WURTZBURG

This photo was taken some years later which accounts for presence of electric lights, etc.

To my view there are two methods of research, the apparatus and calculation. Whoever prefers the first method is an experimenter; otherwise he is a mathematical physicist."—ROENTGEN.

Fifty Years Progress

1945



MILLION VOLT GENERATOR BEING PLACED IN POSITION FOR RADIOGRAPHY OF STEEL CASTING

"Compared to the inner satisfaction over a problem successfully solved, any outside recognition becomes meaningless."—ROENTGEN.

Industrial Million Volt Generators

A Comparative Study of These and Medical Roentgen Ray Units

By HERBERT MERMAGEN

Director, the Industrial Million Volt Roentgen Laboratory
The University of Rochester, Rochester, N.Y.

Equipment:

IT has been said that there have been no developments in the field of Roentgen Radiation Physics since the discovery of the radiation in 1895. This statement can be accepted as correct and further knowledge gained since the discovery has been based largely on the physical principles outlined by the discoverer. Technical developments, however, have kept pace with the general trend of mechanical, electrical and medical achievements accomplished during the past fifty years. Although these developments have perhaps made a more spectacular showing in the field of medical radiology, the application of Roentgen Rays in industrial examinations of materials has by no means been dormant since the beginning of World War II. The very stringent requirements by Government Agencies imposed upon the producers of castings and weldments required drastic redesigning of existing Roentgen equipment. It would lead too far beyond the scope of this discussion to debate the numerous steps of ingenious changes in equipment necessitated for the nondestructive method of material testing in industry.

The most drastic step taken in the development of super voltage Roentgen Generators can be considered to be the engineering of the 1000 KV General Electric Generator. The radical differences in design of such equipment suggest an interesting study of the physical phenomena incorporated in this generator. In this discussion only the fundamental principles shall be briefly described and compared with the conventional medical Roentgen Generators for either radiographic or therapeutic uses.

The study of the behaviour of supervoltage roentgen rays was carried on as early as 1934. However, the year 1940 must be recorded as the period of greatest impetus to the design of industrially useful supervoltage generators. Names such as Charlton, Hubbard, Van de Graaf, Westendorp and Hotaling, Trump and Dempster are all intimately connected with the engineering of high voltage equipment such as electrostatic, constant potential, alternating current resonant transformers, and cascaded transformer rectifier types of generators. The resonant transformer type, regarded as the most flexible million volt generator, is referred to in this comparison. The chief difference between the latter and the conventional roentgen generator lies in the method of producing the high voltage for the roentgen ray tube. Where medical diagnostic equipment employs the standard iron core step-up transformer operating on a well-known principle of voltage transformation according to turn ratio, the resonant transformer uses the physical principle of electrical resonance for the production of super voltages. Briefly it should be stated that in a resonance circuit consisting of an inductance connected in series with a condenser it is possible to obtain a voltage across the

Read at Third Annual Convention, C.S.R.T., Montreal, June, 1945.

inductance far in excess of the voltage introduced into the circuit. No iron core is necessary for such a transformer and thereby a substantial weight reduction can be achieved. This omission of an iron core also provides a convenient space in which the roentgen ray tube may be installed. (Figure 1.) Engineering features thus permit a radically new design in the tube construction as described later. The conventional insulation of medical high voltage generators is provided by a high grade transformer oil. In the 1000 KV resonant transformer the insulation is furnished by a gas, Freon-F12, which at 60 pounds per inch pressure proves to have ample dielectric strength to harness voltages of 1000 KV. Again the use of gas serves as a reduction of weight and thus increases the mobility of such a unit.

The roentgen ray tube, specifically designed for operation in conjunction with the resonant transformer, reveals features which in comparison with conventional tubes require description. In addition to the usual essentials such as filament, target and vacuum, this tube consists of individual sections which are fitted with electron accelerators, each electrically connected to sections of the secondary of the resonant transformer. (Figure 2.) These accelerator cylinders impart to the electron stream emitted from the cathode velocities equivalent to approximately 85,000 volts each. Twelve such accelerations result in a final electron velocity of 1000 KV. Focusing of the electron beam cannot be accomplshed in the usual manner by means of a focussing cup at the cathode because of the excessiveiy long distance of filament to

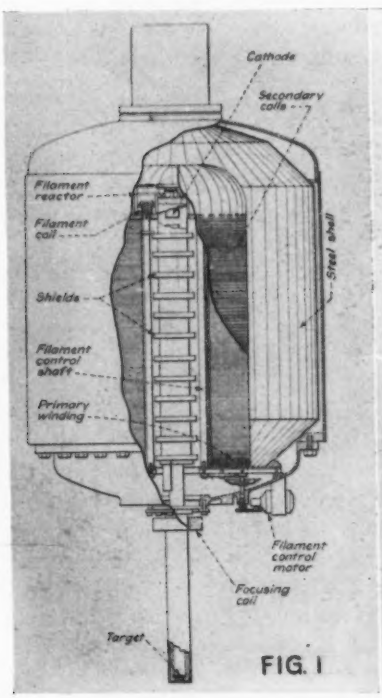


FIG. 1

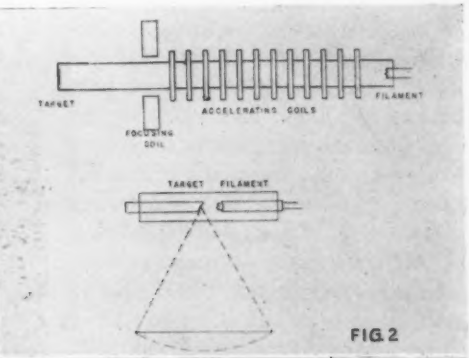


FIG. 2

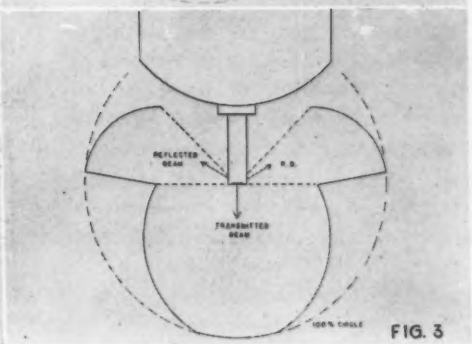


FIG. 3

Fig. 1. Schematic cut of Million Volt Generator Fig 2. Schematic comparison of Million Volt X-Ray Tube and Medical Tube Fig. 3. Radiation Distribution of Million Volt X-Ray Tube

target; this problem was solved by a magnetic focusing coil, through the centre of which the electron stream must pass. Control of current flow through this magnetic lens establishes accurately the size of the focal spot for various loads through the tube. The target, contrary to the conventional roentgen ray target, provides a transmission as well as reflection type of anode, i.e., radiation produced may be employed either as a transmitted beam through the material of the target, or in the conventional manner as reflected radiation. The material which forms the target consists of tungsten as in medical tubes and is subject to the same loading capacities as prevail in lower voltage tubes. Since the construction of the million volt roentgen ray tubes permits the location of the target outside the high voltage generator, it becomes convenient to think of the focal spot as the centre of a sphere, producing useful radiation with spherical distribution. The only useful radiation from the focal spot of a medical tube is generally restricted to a cone with the apex at the target covering a circular area. It is interesting to note that the spherical distribution about the 1000 KV target is by no means uniform but resembles in cross section that of a mushroom. (Figure 3.) The lack of uniformity is explained by the non-uniform absorption in the target of transmitted radiation at increasing angles from the central ray. The feature of spherical energy distribution is of great value in industrial applications as shown later.

Comparison between the electrical maximum values of 1000 KV and medical generators should prove to be interesting information. A resonant transformer generator operated at maximum of 1000 KV is limited to a maximum tube current of 3 MA. Any other current value, however, can be selected from 0.01 MA to 3.0 MA, depending on the required amount of exposure for the examination at hand. Timing of exposure is accomplished by a 0-55 minute synchronous timer. The values just outlined are hardly comparable with the numerous combinations which are achieved in medical diagnostic apparatus but are in fact quite sufficient for the production of industrial radiographs of a wide variety of materials. (Fig. Frontispiece.)

There remains a discussion concerning the mobility of such super voltage roentgen ray generators. As was mentioned above, the reduction of weight and unwieldy size due to the omission of an iron core and also the replacement of insulation oil by Freon gas made it possible to construct the entire unit inside a steel tank 4 feet high and 3 feet in diameter with a total weight of approximately 1800 pounds. Such

Fig. 5.. View of Generator and Crane Assembly

a comparatively small weight and size could therefore be suspended from a hoisting mechanism which is considered standard equipment in industrial installations. The mounting of the tank permits not only raising and lowering but provisions are made for rotation of the unit about its long axis as well as tilting the unit through an arc of 240 degrees. Flexibility in such measure provides the operator with positioning possibilities similar to the most complex medical installations.

Techniques:

The analysis of differences between industrial 1000 KV and medical radiographic techniques can be divided into two parts: the subject or material to be examined and the radiographic factors and necessary accessories. The all too familiar anatomy of medical patients leaves little to be said concerning the type of material under examination; soft tissue — either muscle fibre or adipose tissue and bone tissue make up the differential materials of concern to the medical roentgen technician. Densities of these tissues provide no problem in estimating correct exposure values. In the field of industrial radiology the variety of subjects to be examined differ considerably in density as well as shape, size and thickness. All these properties must be accurately known in numerical values before any decision is made concerning radiographic exposure factors.

The knowledge of roentgen absorption coefficients, seldom employed in medical radiography, becomes an important factor in the radiography of metals. A brief review of the usefulness of this factor may lead to a better understanding of its value. Absorption of roentgen radiation follows a law which states that a quantity of radiation incident upon a material of thickness x and predetermined absorption coefficient u (mu) suffers a reduction in intensity according to the equation $I = I_o e^{-ux}$, where I is the transmitted intensity, I_o the incident energy, u the absorption coefficient and x the thickness of the material, e being the basis of the Naperian logarithms and the negative sign signifies the decrease of intensity. The value for u or absorption coefficient is obtained from tables and denotes the degree of absorption which may be expected at different x-ray wavelengths corresponding to many voltages. This relation of absorption coefficient to kilovoltage becomes the governing factor for partially determining the subject contrast which can be photographically recorded. Changes in the quality of radiation by means of variations in voltage bring about significant changes in the numerical values of absorption coefficients. A table illustrates such changes for several elements. (Figure 6.) It can be seen that as the voltage applied to the tube is increased the differences of values for the mentioned elements become less until at 1000 KV all five elements have absorption coefficients with nearly identical values. This latter fact is most important in

MASS ABSORPTION COEFFICIENTS

KVP	Shortest Wave Length	C	AL	FE	CU	PB
100	0.123 "A"	.150	.173	.368	.455	5.20
200	0.075	.140	.147	.220	.250	2.33
400	0.031	.095	.093	.095	.100	0.38
1000	0.02	.058	.056	.055	.054	0.067

Figure 6. Table of several materials and their absorption coefficients for several x-ray voltages.

industrial million volt radiography insofar as it predicts the degree of subject contrast available for recording on photographic emulsions. As an example the following conditions should be recalled: Radiographs of a lumbar spine exposed with a relatively low voltage of 50 KVP will demonstrate much higher contrast values than radiographs obtained with an exposure at 100 KVP. Although such great differences may not occur in routine work they illustrate distinctly a decrease of film contrast at the higher KVP which is partially due to the reduction of absorption coefficients of the object.

In industrial radiography similar observations are made. An object varying greatly in thickness is considered to have high external subject contrast as compared with an object of uniform thickness having no contrast at all. (Figure 7.) Another type of subject contrast called internal S.C. is that produced by materials of different absorption coefficients. Since industrial radiography is concerned with the soundness of metals this latter type of contrast becomes the more important of the two. Defects in a metal may be either a cavity or an inclusion; both types of defects usually contain materials different from the base metal such as gas, slag, sand or foreign bodies, all of which may have widely varying absorption coefficients. These density variations occurring between base metal and possible defects result in differential absorption of roentgen rays and thus can be spoken of as internal subject contrast. As demonstrated above, any increase of energizing voltage giving rise to shorter roentgen wavelengths will tend to minimize the numerical value of absorption coefficients and therefore reduce the ultimate internal subject contrast. This available subject contrast becomes quite low at radiations from million volt generators and particular effort must be made to obtain the highest possible contrast on the recording film. Such difficulties are not experienced in the medical field and therefore no film types need be considered other than one to be used with intensifying screens for very rapid exposures and another for direct exposure.

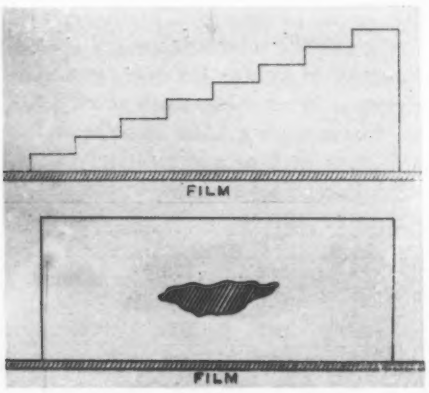


Fig. 7. Schematic Illustration of Subject Contrast

For industrial purposes of recording either soundness or defects in materials five essentially different types of film are manufactured and the choice of the correct film for a particular application has become most valuable. The grading of these latter industrial film types is made according to their speed. In general it is found that a film with very high speed will demonstrate only moderate contrast against a film with very high contrast rendition which as a rule displays a slow speed. From consideration above it follows that at radiation voltages of 1000 KV it becomes highly desirable to employ a film type with the utmost contrast availability.

Exposure and film development in the medical field is usually carried out according to the desire of the roent-

genologist, i.e., some laboratories produce films with average film densities of 1.5 to 2.0 and others prefer such densities to be 0.5 to 1.5. This personal choice for the most pleasing radiographic recording had to be eliminated for industrial radiographic laboratories since standardization could not be possible with film densities covering a range of densities from 0.5 to 2.0. Accepted standard densities are between 2.0 and 2.5 for million volt radiographs. These comparatively high density requirements are based on the fact that roentgen films render considerably higher contrast at such densities, as can be shown by the slope of the film characteristic curves. (Figure 8.)

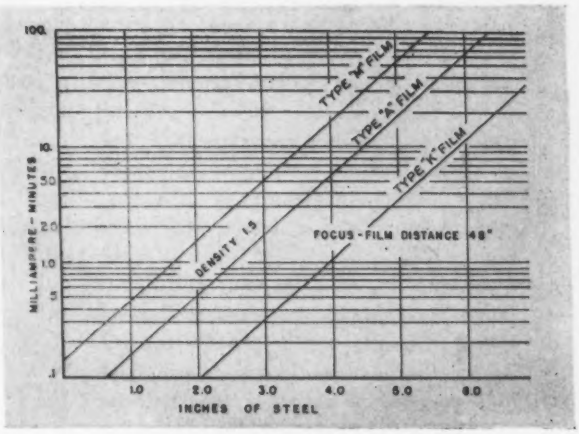


Fig. 9. Million Volt Exposure Chart

In the following discussion of exposure factors for 1000 KV radiography no comparisons are given with medical radiographic factors since in most medical laboratories these factors vary considerably in accordance with the type of equipment used. Exposure charts for 1000 KV installations are more simplified than any medical exposure charts or low voltage industrial exposure charts. Usually a graph having thickness plotted against exposure in terms of milliampere minutes is all that it needed. Other factors such as type of material, focus — film distance, type of film and types of screens are constants and are noted as such. A typical 1000 KV exposure chart is illustrated. (Figure 9.) All constants are self explanatory with the exception of intensifying screens. These constitute a definite variation from those employed in medical radiography since they are not calcium tungstate screens but thin sheet lead mounted on a cardboard base. Fluorescent intensifying screens cannot be used with million volt radiation because the rendition of contrast with such screens decreases rapidly with increasing x-ray voltages. The intensifying action of lead screens depends on an entirely different principle. When million volt roentgen rays strike an object they dislodge electrons which

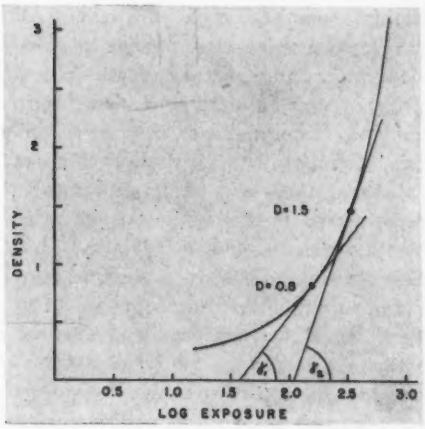
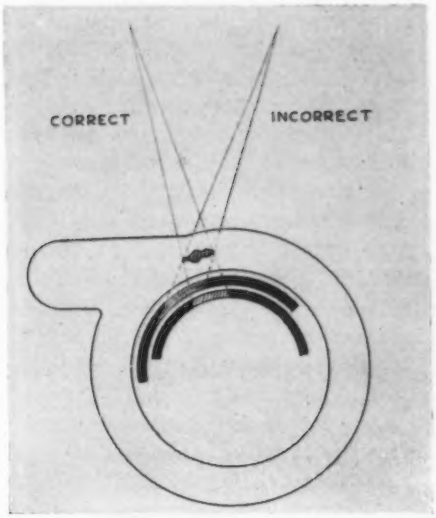


Fig. 8. Film Characteristic Curve Illustrating the Change in Contrast (Gamma) with Higher Densities

although very quickly absorbed in air can be made to act on a photographic emulsion and thus assist in reducing exposure time. This phenomenon forms the basis for the use of lead screens in 1000 KV radiography. The usual precautions pertaining to screen film contact and cleanliness of screen surface must be observed for best results.

Another factor of considerable magnitude is that of scattered radiation. While this undesirable feature is ever present both in medical and industrial radiography, it has been largely eliminated from expending its energy in the production of fog by the use of a Potter-Bucky diaphragm. Such apparatus unfortunately is not available for million volt work. The best known method for reducing million volt scattered radiation remains a filter which is placed between the object and the film holder. The use of x-ray filters in the medical field has been reduced largely to initial beam filtration and is seldom employed for removal of scattered radiation. This filtration of the roentgen rays as they emerge from the tube tends to homogenize the beam, i.e., it reduces the percentage of long wavelength radiation and it is this same physical phenomenon which renders such a device helpful in million volt work for the partial removal of long wavelength scattered radiation arising within the object under test. The material from which these filters are constructed is generally lead sheet and the thickness used may be from 1/16″ to ½″. Lead as a filter material may be considered paradoxical but the realization that radiation from 1000 KV generators will penetrate 3.5 inches of lead will explain that no difficulty exists in the penetration of 0.5″ of lead in the form of a filter. The removal of scattered radiation by lead filters is not the only method at the disposal of the million volt technician. On many occasions it is not feasible or even advisable to apply such filtration and recourse is taken to carefully blocking unwanted radiation from reaching the film. Solution of such a problem of localizing the radiation beam to a specific portion does not entail any difficulty in medical radiography since the simple device of a diaphragm or cone at the source of radiation can be accurately chosen for any desired coverage of area. This restriction of area in industrial million volt radiography must be carried out at the object and in many instances that procedure becomes a tedious task. Oftentimes it cannot be avoided that a lead casting must be made which fits closely all portions of the object surrounding the area for inspection. Occasionally it is possible to shield or block an area with copper shot, a very finely divided pure metallic copper powder which has high roentgen ray absorption even at super voltages of 1000 KV.

The question of positioning the part for radiography in industrial application of roentgen rays follows similar well known rules as found in the medical field. The portion of the object to be examined should be recorded with the least amount of geometrical distortion. (Figure 10.) Although in most industrial cases not much difficulty is encountered in this respect there arise many problems where it appears impossible to follow this simple rule. This can be substantiated by the enormous variety of contours and outlines which are found in industrial designs. No positioning handbooks ever take the place of a standard guide similar to those by which the medical technician plans his or her positioning of a



RELATION OF IMAGE DISTORTION TO INCORRECT BEAM ANGLE

Fig. 10. Geometric Distortion of Image and its Correction by a Change in Beam Angulation

patient. Such lack of standard guides places a responsibility on the industrial roentgen technician which obliges him to either construct a drawing of the part with indications of placements of film as well as the accurate directions of the roentgen beams, or to photograph the entire set-up so that the interpreter of the radiographs is able to reconstruct the conditions which prevailed during the exposure.

Some actual exposure factors may prove to be of interest. A steel plate of 3″ thickness is to be examined after the welding. The potential of 1000 KV is accepted as a constant. At the focal film distance chosen as 8 feet, 3 MA are required for a time of 4 minutes. A slow speed film with high contrast availability placed between lead screens .010″ thick, insured best rendition of the quality of the weld. Another example may further illustrate exposure conditions. A bronze casting for a high pressure marine engine contains an area of intense stress. It is imperative that the section be radiographed.

Thickness (1) 4.3″ and (2) 5.5″	
Exposure for 4.3″	Exposure for 5.5″
1000 KV	1000 KV
3 MA	3 MA
6 Feet F.F. Dist.	5 Feet F.F. Dist.
6.5 Min.	10.0 Min.

Medium speed and contrast film

Both films developed to a density of 2.0 H. & D. At this point in the procedure of making a radiograph the responsibility of the medical technician is ended. Interpretation of the films becomes the work of the radiological physician.

The interpretation of industrial radiographs becomes as much a part of the responsibility of the industrial technician as is the production of the radiograph. This of course presumes that the training of industrial roentgen laboratory personnel should include knowledge of metallurgy, foundry practice, welding procedures, structural mechanics, and strength of materials. Without that knowledge it would be folly to make decisions on the acceptance or rejection of important industrial materials. Recognition of radiographic densities as defects can be accomplished after a short training period, but the correlation of the defect with design requirements can only be interpreted after the consultation of blueprints and specifications, also after conferring with the engineer, foundrymen or welding authority.

A short discussion of the most common defects may serve to make the reader acquainted with the appearance of such defects on radiographs.

(1) Cracks.

These serious defects appear as sharply defined lines of high densities. The radiographic procedure for obtaining successful rendition of this

type of defect must be painstakingly accurate since it is easily possible to miss this defect entirely if the plane of the crack does not coincide with the direction of the central ray. A number of films must be produced with slight changes in angulation of the x-ray beam to accurately localize the position of the crack.

(2) Inclusions.

These defects appear as very irregular shadows on the radiograph and are easily recognized as such after a short training period.

(3) Gas Cavities.

The appearance of such cavities is most frequently seen as a circular shadow with occasional irregular but rounded contours.

(4) Shrinkage.

The origin of such defects is explained by the production of voids due to the cooling and solidification of metals within the molds. Their distinct outlines appear as most irregular shadows consisting of a main cavity with many branch cavities leading away from the central shadow. The outlines are sharply defined and suggest shadows of tree branches after the removal of all leaves.

The aforementioned defects are not very demonstrative or photogenic and their reproduction has therefore been omitted.

In closing, a paragraph concerning the aspects of radiation safety in a million volt roentgen laboratory should be included, which illustrate the precautions to be observed in any high voltage laboratory. As was mentioned above 1000 KV radiation is not entirely absorbed in 3.5 inches of lead, and in order to protect the operating personnel it is advisable to increase the lead protection to at least 4 inches of lead or an equivalent material. Concrete for radiation protection has been suggested by the U.S. Bureau of Standards and this material was successfully employed at our own laboratory. Since the recommendation of the Bureau of Standards included 600 KV radiation as the highest available voltage at the time of publication it became necessary to extrapolate concrete thickness values from existing data. The final safe thickness was calculated at three feet of concrete. After the construction of the laboratory accurate transmission measurements were made with a specially designed instrument capable of direct registration of roentgen values per eight hour day. The values recorded represent about four ten-thousands of one "r" per 8 hour day for direct transmission of maximum beam power. This small quantity of radiation is considered absolutely safe for the operating personnel since the recommended quantity of roentgen exposure per 8 hour day shall never exceed 0.1 r/8hrs.

"The greatest and most beautiful joy the scientist can experience, no matter what problems he may be studying, is unprejudiced research."—ROENTGEN.

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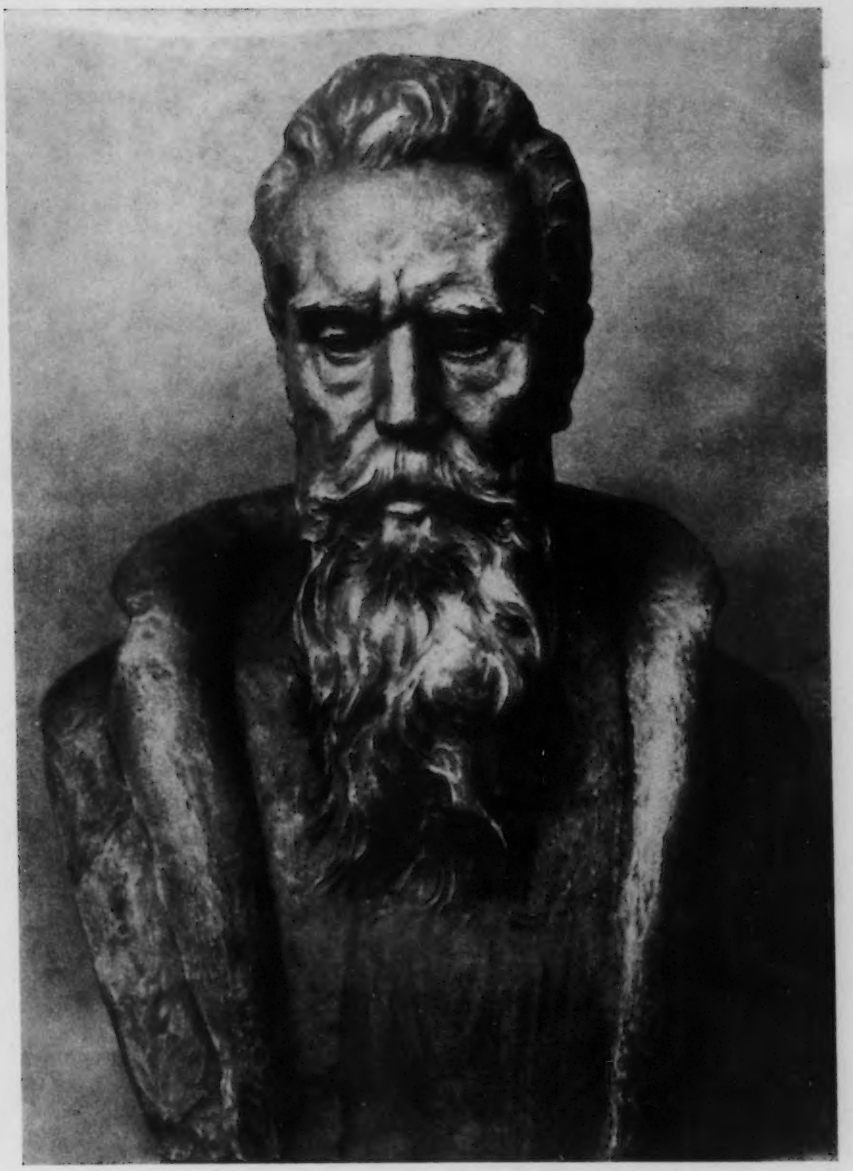
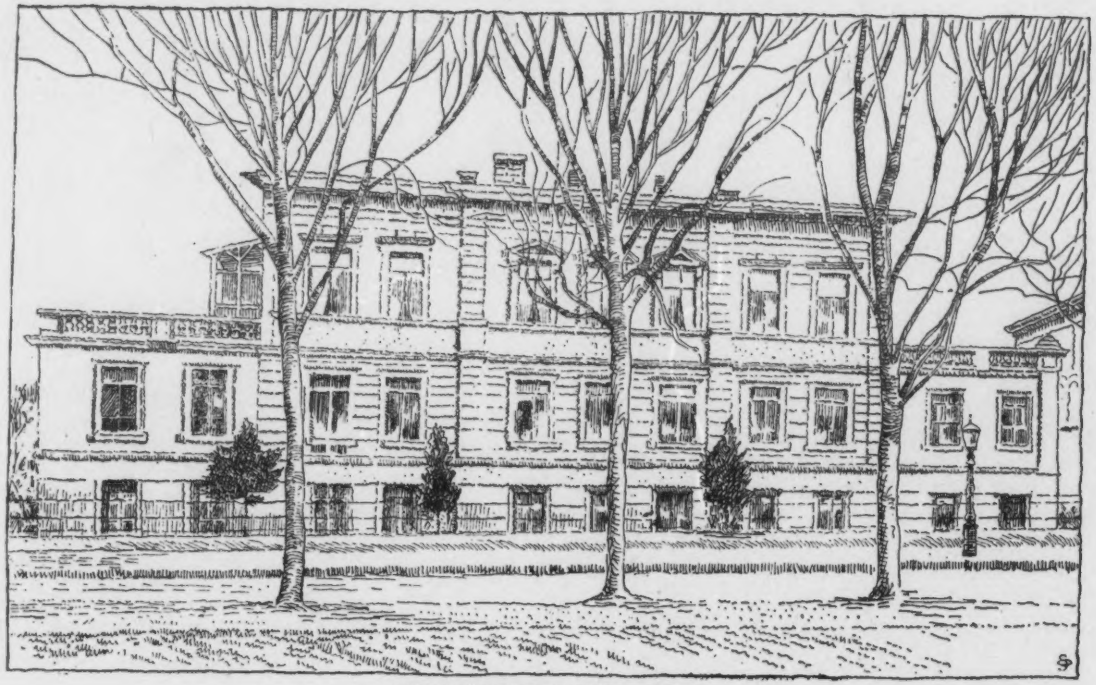


WILHELM CONRAD ROENTGEN

1845 — 1923



WURZBURG INSTITUTE.

Drawn by Owen Staples, O.S.A.

Original in possession of Dr. G. E. Richards

ROENTGEN

A BRIEF BIOGRAPHY

By PERCY GHENT, Toronto

HISTORICAL

ABOUT the middle of the eighteenth century, the Abbe Jean Antoine Nollet, French physicist of peasant birth, exhibited before the amused eyes of the dilettanti savants of his day, certain phases of electrical phenomena, the result of many hours of intensive study in his quaint laboratory. They beheld, for instance, a curious, ovoid contrivance of glass, which Nollet called, not inappropriately, the "electric egg". It had been rarefied, more or less, by means of the air-pump devised in 1650 by Otto von Guericke, versatile mayor of Magdeburg, and, energized by a static machine, a spark was made to leap across this egg-like device with a crackling—or should we say cackling?—sound. Crude and primitive as this glass bulb of Nollet's undoubtedly was, it represented, perhaps, the earliest and humblest ancestor of the modern vacuum tube of marvellous performance, and as such, commands respect. Following the experiments of the French physicist, nearly a century elapsed in this field of scientific research without recorded progress of great significance.

Then came the momentous work of one of the greatest modern scientists Michael Faraday, one-time messenger boy and book-binder's apprentice. His interest in books seems to have penetrated more deeply than the binding, for when, in the course of business, a few scientific works fell into his hands, he read them with such avidity and profit that he forthwith dedicated his life to the study of electricity. To the patient study and endless experiments of this modest Englishman, we are indebted very largely, for the production of electrical power as we now have it, for it was his discovery of the phenomenon of electro-magnetic induction that made this development possible.

Brilliant research was followed out by Farraday in 1837 and later, on the luminous effects created in various gases by electric discharges, noting the rich and varied colors of the discharge in nitrogen, and the modified tints in hydrogen and oxygen, changing with degrees of atmospheric rarefaction. His work marked the true beginning of the long series of investigations that ultimately brought about the discovery of the x-ray, and the way to further exploration which he pointed out, was soon to be followed by others. Abria did some interesting work with induced voltaic current in rarefied gases in 1842, and an important forward step was made some years later by Plucker,

for whom Geissler had produced the first tube in which a vacuum, although a low one, could be indefinitely maintained. Electrodes of platinum wire were fused into the walls of the Geissler tube, which Plucker then excited with electric current, creating attractive luminous colors and striae at the cathode end.

In 1869 Hittorf made important researches which led to the discovery of hitherto unsuspected rays which appeared to originate at the negative pole. Scant attention was paid to them, however, until the absorbing experiments of Crookes in 1879, when the cathode stream was described in a brilliant, masterly way, rarely excelled. His prophetic words concerning this phenomenon, unlike any other solid, liquid, or gaseous manifestation, but rather a "fourth estate of matter," only serve to stress that almost tragic episode of experimental science, when a strange caprice of fortune permitted this master-physicist to produce x-rays, as he undoubtedly did, and yet not actually discover them. Hertz, in 1892, conducted experiments which led him to the conclusion that the cathode stream could pass through the glass walls of the tube and suggested further investigation outside the vacuum. After the death of Hertz, his pupil, Lenard, entered this phase of exploration with keen engagement, coaxing the cathode stream out of the tube by means of an aluminum window, and noted its effects, including the fogging of photographic emulsion, with surpassing care. Lenard's work was the final step of a long journey in science, before the actual discovery of the x-ray. Von Guericke, Nollet, Faraday, Plucker, Geissler, Gassiot, Hittorf, Morgan, Crookes, Thomson, Hertz, Lenard, and many other patient trail-blazers of science, share in the glory of this profound achievement. But to Roentgen belongs the supreme honor of having first recognized the existence of that new, unseen, and mysterious radiation, the discovery of which had been made possible by the labors of his predecessors, who builded better than they knew.

A solitary worker in his simple laboratory in Wurzburg, on that historic Friday the eighth day of November, 1895, his Crookes tube hidden beneath a light-proof shield of black cardboard and excited by a Ruhmkorff coil, he had observed, in the darkened room, the weird glow on that momentous scrap of paper coated with barium platino-cyanide, and made those investigations which gave to mankind in that dramatic moment, a new degree of vision. And with a restraint almost super-human, he devoted nearly two months to the intensive investigation of his great revelation before announcing it to the world.

A number of versions of the story of Roentgen's discovery have appeared, and several writers have strong emphasized the part which accident and chance played in it. But was it accident? Here was a man, long interested in this phase of physics, deliberately covering his Crookes tube, thereby

hiding from view all the then known phenomena of the excited vacuum tube, and obviously prepared for a new manifestation, if such could be evoked. So well prepared, indeed, that when the great secret was wrested from Nature, the spectacular revelation did not drive him into any hasty, fantastic speculations, but with cold-blooded, calm persistence, he pursued and elaborated his discovery with a thoroughness and accuracy attested by his first epoch-making pronouncement.

And supposing chance did come to his aid? Said Hugo Musterberg of Harvard:

> "There were many galvanic effects before Galvani saw, by chance, the contraction of a frog's leg on an iron gate. The world is always full of such chances, and only the Galvanis and Roentgens are few."

In one strikingly apt and arresting sentence, the writer of an editorial appearing in the "Journal of Roentgenology," shortly after the discoverer's death, thus sums up Roentgen's title to the gratitude and admiration of his fellow-men:

> "The flash of the fluorescent cardboard had to be answered by a flash of genius, and the rest was merely a matter of detail."

Roentgen, to his eternal honor, supplied that divine spark—and it set the scientific world on fire.

BIOGRAPHICAL

1845 — 1895

AMONG the stately hills of the lower Rhine, eighteen miles or so east of the busy industrial centre of Dusseldorf, lies the little town of Lennep, its citizens engaged mainly in the manufacture of woollens, cotton and steel. Here on the 27th of March, 1845, was born Wilhelm Conrad Roentgen. His father, Frederich Conrad, was a Prussian in moderate circumstances; his mother a native of Utrecht, Holland. Both parents seem to have been well blessed with those sterling, simple virtues of patience, industry, love of truth and modesty, which their only child inherited. Modesty, indeed, was so deeply ingrained in Roentgen's sincere nature, that even after his astonishing discovery had focussed the attention of the world upon him, he still found it difficult to understand why that world should be interested, in what to him, seemed the non-essential matters of his personal history, or his sympathies outside the sphere of his life work. Because of this quality of self-effacement, little seems to have been known, or at all events, written, about his early life. Certainly from the meagre details of his boyhood thus far available, it would be difficult to glean anything to show wherein the child was father to the man. There is no record of precocity such as stamped Wolfe as a soldier, even in his tender years; no boyish resolve to become a leader in science as Pitt had resolved to scale the heights of statesmanship; none of the intense, early application to study of a Faraday; no brave, youthful words about hitching his wagon to a star.

Many extraordinary men, after all, have been very ordinary boys, and Roentgen appears to have been just a normal, care-free lad, growing up, however, amid home influences of old-fashioned piety, thrift, and regularity, which have often proved so firm a foundation whereon to build a great career. No serious liberties would be taken with the truth were it assumed that Roentgen's life-long habit of reading the Bible was inspired by parental example.

His early boyhood was spent in Utrecht, that ancient city of Holland on the still more ancient Rhine; and its quaint canals, stone bridges, imposing Gothic cathedral, and handsome public buildings must have furnished his young mind with many cherished memories. Here he received his primary education. He was next sent to the agricultural school at Apeldoorn, one of the most charming little towns of Holland, approached by majestic avenues of century-old elms; famed for its flower gardens, and near to Castle Loo, delightful country seat of the Dutch royal family. Ample opportunity was

found here to indulge that keen, inbred love of nature that was to bring him many hours of solace and recreation in later life, and, a sturdy youth, he entered with zest into the games and sports of his fellow-students. Life and study were not taken too seriously; hours of idle dreaming were not deemed ill-spent, and the days sped by happily enough. Happy days indeed, but Fate, waiting around the corner in the guise of a so-called trivial incident, brought them to an abrupt conclusion. Trivial! A soul-stirring volume could be written on the Might of Triviality. Newton sees an apple fall and interprets the law of gravity. Bunyan, on the trivial rebuke of a shrew for his profanity, is stung to reformation, dreams his Dream, and gives to the world a book which places him among the immortals. Roentgen, accused of participation in some mad student prank, pleads guilty, but with high ideals of schoolboy honor, stolidly declines to divulge to the Apeldoorn pedagogue in that mild inquisition, the identity of his fellow-conspirators. Loyalty to school friends brought the penalty of dismissal, and he was forced by trivial circumstances or kindly Providence, if you will, into a new path of knowledge, a changed direction of thought and ambition, that led, through time, to the discovery of the x-ray. And, losing a mechanic, the world gained a genius.

This somewhat precipitous exit from Apeldoorn, and the failure to pass an examination, seemingly blocked the way to further advance in his academic course, for he lacked the credentials of matriculation. But it was revealed in some happy moment, that the Polytechnical Institute at Zurich was open to students of promise without the fees. Thrice blessed be the men who made the portals of that shrine of Wisdom so wide and inviting. Entering this famed Swiss school, he glimpsed for the first time, perhaps, those towering heights of exploratory physics wherein he was destined to make so notable a conquest. Not that he made any fevered start with all-absorbing energy toward that goal. Even the spell wrought upon him by Clausius, famed expounder of the science, was rivalled by the perennial lure of the snow-capped peaks of the nearby Engadine, and he oft forsook the laboratory and the lecture hall for the quest of Alpine flowers, or the soul-satisfying adoration of the mountains. Throughout his long career Roentgen loved these cloud-crowned peaks, journeyed to them frequently; dreamed of them to the last lonely moments of his life. It would be easy to imagine one of his favorite biblical texts to have been:

"I will lift up mine eyes unto the hills,
from whence cometh my help."

for, most assuredly, his love of the mountains frequently brought relief in perplexity; balm for the irritating, petty cares of existence; renewed energy for grappling with the problems of the physical laboratory.

Clausius, propounding many original theories in the physics of heat, gases, and molecular phenomena, exerted a fruitful influence on the receptive mind of young Roentgen. Development of even greater significance resulted from his association with Kundt, who seems to have taken an unusual interest in this shy, reticent pupil, in whom he must have seen some promise of future greatness. To this teacher and friend, Roentgen owed much for the thoroughness and accuracy in practical research, and readily acknowledged the debt. Thus at the feet of these outstanding masters, and a voluntary, assiduous student in the School of Experimental Physics, he made striking progress which did much to compensate for the defects attributable to the interrupted training of his earlier schooldays.

In 1869, at the age of twenty-four, he was graduated from Zurich as Doctor of Philosophy, a degree earned by work assigned to him by Kundt. Called to Wurzburg, this same faithful friend took the future discoverer with him. But, learning of Roentgen's failure to conform with the regular routine of academical progress in previous years, there was considerable wrinkling of the lofty, intellectual foreheads, some elevation of the eyebrows, and polite regrets expressed that no place on the staff seemed to be available at the moment. They could not foresee the day, of course, when the work of this obscure, unimportant young man would bring a glory to their ancient institution, brighter, more lasting, than any created in all the hoary centuries of its previous existence. Determined, however, to work in association with his young protege, Kundt shortly afterwards transferred to the recently founded University of Strassburg, where social and academic barriers were neither so high nor so strict as at Wurzburg, and Roentgen, who had met the woman who became his wife at the latter city, settled down to an appointment at Strassburg, becoming, in 1872, privat-dozent in physics.

There would appear to be no equivalent of the German privat-dozent in the university life of any other country. It is a unique, Teutonic idea, and an institution held by many to be responsible in some degree for the high intellectual standing attained by the average German graduate. Untrammeled by any strict schedule of teaching routine, either of subject or the manner of its expounding, the privat-dozent is the free rival of the professors in whose realms he lectures; a sort of academic free-lance, thrusting deeply where his seniors have touched but lightly; specializing in fields wherein the students feel they are weak. He is often brilliant, and usually popular with the pupils to whom he can be of so great service. With no particular love for the humdrum of standardized routine, it is more than likely that Roentgen enjoyed his dozentship intensely, and he must have created an excellent impression, for thereafter his way was smooth and progress consistent.

Appointed at the age of thirty to the professorship of mathematics and physics in the Academy at Hohenheim, he resigned in but a few months to return, at Kund't request, to Strassburg, as associate professor of theoretical physics. This appointment he held for three years. What were the thoughts of the quiet young teacher as he strolled about the quaint streets of the ancient city of Strassburg, capital of that beloved province of Alsace, wrested from France but three or four years before by the might of Bismarck's armies. As a loyal German no doubt he was proud of this new and wealthy acquisition of the Fatherland, but the bitterness of the first years of annexation must have inspired some long and sober thoughts.

At thirty-four he is full professor of experimental physics at the thriving University of Giessen, a serene little town of Hesse, forty miles north of Frankfort-on-the-Main. He found the atmosphere of this university town friendly and congenial, was a welcomed visitor in many homes, worked happily in the well-equipped laboratories, and, after nearly a decade of the pleasantest kind of university life, left, with regret, for a similar position in the larger sphere of Wurzburg. With the passing of the years a change of heart and opinion has occurred in Wurzburg, for now he is deemed worthy to succeed the brilliant Kohlrausch. This was in 1888. Here, seven years later, occurred the phenomenal discovery that made Roentgen famous.

DISCOVERY

A NEAT and thriving town of more than fifty-thousand souls, nestling beside the Main, Wurzburg, in this age, is one of the chief industrial and educational centres of Bavaria. Relics of its ecclesiastical importance in the Middle Ages remain in the shape of a notable Romanesque cathedral, erected in the 10th century; a long stone bridge adorned with statues of the saints which spans the river; and many buildings of quaint, mediaeval architecture. Elaborate fortifications that once defended the ancient town, have given place to handsome promenades, but the famed old fortress of Marienberg still frowns from its commanding height. On the slopes of nearby hills flourish vineyards which produce famous wines, while other industries, less ancient and picturesque, thrive within the town. Its university, of Roman Catholic adherence, was founded originally in 1403. Save for these things, and perhaps for the unusual excellence of its local beer, Wurzburg, for centuries, made no salient claim upon the attention of the world until late in the year of grace, 1895.

It was early November, and along the tree-lined streets, strolled stolid Bavarian students, their caps of scarlet, green, or blue, adding bright flashes of color to the Autumn tints. More than a thousand of these students had enrolled for instruction in that Fall of 1895, so that the Pleicher Ring, a fine avenue with a park on one side of it and the main group of the scattered university buildings on the other, presented a veritable feast of color. Here is situated the Physical Institute, a modest, two-storey building with a roomy basement. It was the particular domain of Wilhelm Conrad Roentgen, who had his residence on the upper floor, and conducted his lectures and experiments in the remainder of the building. A tablet now proudly announces that here were discovered the Roentgen rays, and a handsome boulevard in the city perpetuates the name of their discoverer. But on this November day, as on countless days before, the Physical Institute was merely one of the many university buildings, and the unassuming man who quietly worked within but one of the four-score professors or teachers of the university staff. What, precisely, happened in that dim laboratory that made this building assume thereafter so unique an interest, and caused that comparatively obscure professor to be suddenly counted among the great? In what manner came the revelation that made the world open wide its eyes in wonder, and sent the correspondents of the great journals scurrying post haste to Wurzburg? Fifty years have elapsed since the discovery not only created the science of radiology, but marked the beginning of a new era of scientific thought, shaking the smug complacency of the Victorian age to its very

depths. Fifty years of marvellous advancement, elaboration, and increasing complexity. It would be refreshing, therefore, to return for a moment to the fundamental simplicity of those earliest days, and hear the story of the event in the words of a man who had the priceless privilege of an interview with Roentgen in the first flush of his momentous revelation. His name was Dam, and he was the London correspondent of an American magazine. (McClure's.)

Among the mass of literature contemporary with the event, nothing has been found to excel the intimate and absorbing story, as presented by this man, and from his record, commencing with the moment of his arrival at the Physical Institute, some generous excerpts are quoted:

> "At the door I was met by an old serving man of the idolatrous order, whose pain was apparent when I asked for 'Professor' Roentgen, and he gently corrected me with 'Herr Doctor Roentgen'. As it was evident, however, that we referred to the same person, he conducted me along a wide, bare hall, running the length of the building, with blackboards and charts on the walls. At the end he showed me into a small room on the right. This contained a large table-desk, and a small table by the window, covered with photographs, while the walls held rows of shelves laden with laboratory and other records. An open door led into a somewhat larger room, perhaps twenty feet by fifteen, and I found myself gazing into a laboratory which was the scene of the discovery—a laboratory which, though in all ways modest, is destined to become enduringly historical."
>
> "There was a wide table-shelf running along the farther side in front of two high windows which gave plenty of light. In the centre was a stove; on the left, a small cabinet whose shelves held the small objects the professor had been using. There was a table in the left-hand corner, and another small table—the one on which living bones were first photographed—was near the stove, and a Ruhmkorff coil was on the right."
>
> "The lesson of the laboratory was eloquent. Compared, for instance, with the elaborate, expensive, and complete apparatus of, say, the University of London, or of any of the great American universities, it was bare and unassuming to a degree. It mutely said, that in the great march of science, it is the genius of man and not the perfection of appliances that breaks new ground in the great territory of the unknown. What possibilities of progress with unlimited and elaborate appliances, when the discoverer himself has done so much with so little?"
>
> "Professor Roentgen entered hurriedly, something like an amiable gust of wind. He is a tall, slender, and loose-limbed man, whose

whole appearance bespeaks enthusiasm and energy. He wore a dark blue, sack suit, and his dark hair stood straight up from his forehead, as if he were permanently electrified by his own enthusiasm. His voice is full and deep, he speaks rapidly, and, altogether, he seems clearly a man who, once upon the trail of a mystery which appealed to him, would pursue it with unremitting vigor. His eyes are kind, quick and penetrating, and there is no doubt that he much prefers gazing at a Crookes tube to beholding a visitor, visitors at present robbing him of much valued time. His greeting, however, was cordial and hearty. In addition to his own language he speaks French well, and English scientifically, which is different from speaking it popularly. These three tongues being more or less within the equipment of his visitor, the conversation proceeded on an international or polyglot basis, so to speak, varying at necessity's demand."

Under good-natured protest, some very brief biographical information was first given, in answer to the interviewer's queries. He declined to look upon himself as being in any way out of the ordnary, and depreciated all eulogy of his achievement, laughing heartily at the idea of being famous. It was evident that the applause of the world embarrassed him.

"Now, then," said he, smiling, and with some impatience when the preliminary questions at which he chafed were over, "you have come to see the invisible rays."

"Is the invisible visible?"

"Not to the eye, but its results are. Come in here."

Roentgen then led the way into his historic laboratory. To obviate the necessity of constantly keeping this room darkened an ingenious sort of light-proof sentry-box had been devised by the scientist. It was made of tin, and a circular window of aluminum had been soldered to one of its sides several feet from the ground. A few inches from the outer aspect of this window, a Crookes tube had been placed. Ensconced within this commodious box, and with his "barium paper" in his hand, the professor studied in solitary security the effects of those marvellous rays which he himself had christened with that brief, scientifically descriptive, and still popular designation "x". Nor does the retention of that designation by so many radiologists, in preference to "roentgen", necessarily indicate lack of appreciation of the scientist who revealed them. Familiar by long usage, eloquent in its simple brevity, the name selected by the master himself it would seem, will never be altogether displaced by the newer term.

Into the cabinet, then, the journalist is ushered, and the door is closed behind him. He has been instructed how to use the little rudimentary fluorescent screen, and a demonstration follows which leaves him momentarily dumfounded. Then he waxes eloquent in his prophecy of future

development, even suggesting the possibility of a tube being devised, small enough for insertion into the human stomach, from which central point of vantage, visualization of surrounding regions might be made, a notion at which Roentgen grows merry. "When I have done this," he laughingly remarks, "I will tell you." In his enthusiasm the visitor is anxious to carry away a souvenir of the occasion, and intimates his desire to purchase the little table on which the first radiograph was made; but the professor smilingly tells him it is not for sale. Next, he begs to be shown how that first—of how many millions?—picture was made, showing the bones of the living subject. Arranging a tube three or four inches from the under-side of the table top on which he places his hand, and with a plate wrapped in black paper resting steadily upon that hand, Roentgen obligingly demonstrates. Then:

"You ought to have your portrait painted in that attitude," I suggested.

"No, that is nonsense," said he, smiling.

"Or be photographed." This suggestion was made with a deeply hidden purpose.

The rays from the Roentgen eyes instantly penetrated its deeply hidden purpose.

"Oh, no," said he, "I can't let you make pictures of me. I am too busy."

Clearly the professor was entirely too modest to gratify the wishes of a curious world.

With the persistence of a true journalist, commendable in this instance at least, he lingers for more information. He has travelled far for his story and is reluctant to leave without a good one. Roentgen is therefore subjected to a questioning as to the precise circumstances of the discovery:

"Now, Professor," said I, "will you tell me the history of the discovery?"

"There is no history," said he, "I have been for a long time interested in the problem of the cathode rays from a vacuum tube, as studied by Hertz and Lenard. I had followed theirs, and other researches with great interest, and determined, as soon as I had time, to make some researches of my own. This time I found at the close of last October. I had been at work for some days when I discovered something new."

"What was the date?"

"The eighth of November."

"And what was the discovery?"

"I was working with a Crookes tube covered by a shield of black cardboard. A piece of barium platino-cyanide paper lay on the bench

there. I had been passing a current through the tube, and I noticed a peculiar black line across the paper."

"What of it?"

"The effect was one which could only be produced, in ordinary parlance, by the passing of light. No light could come from the tube, because the shield which covered it was impervious to any light known, even that of the electric arc."

"And what did you think?"

"I did not think, I investigated. I assumed that the effect must have come from the tube, since its character indicated that it could come from nowhere else. I tested it. In a few minutes there was no doubt about it. Rays were coming from the tube which had a luminescent effect upon the paper. I tried it at greater and greater distances, even at two metres. It seemed at first, a new kind of invisible light. It was clearly something new, something unrecorded."

"Is it light?"

"No."

"Is it electricity?"

"Not in any known form."

"What is it?"

"I don't know."

And the discoverer of the x-rays thus stated, as calmly, his ignorance of their essence, as has everybody else who has written on the phenomena so far."

At the conclusion of the interview, some prints of Roentgen's early radiographs were exhibited. They included a set of laboratory weights photographed within their box, a coil of fine wire on a wooden spool, some compasses in a case, and other simple objects. And carrying away vivid impressions of that unique hour with one of the most outstanding pioneers of science, the journalist took his leave of the old-world town of Wurzburg, wherein had just been born a radiance whose beams were destined to reveal a new world of wonder.

Attributed to Dr. T. S. Middleton of Chicago, who was a student at the Physical Institute in those fateful days of 1895, a story appeared in the course of an article by E. E. Burns, writing for the "Popular Science Monthly" of December, 1898. It concerned the now famous episode of the prophetic image of a key, which came to light on one of Roentgen's photographic plates prior to the discovery, and would seem to be the sole, though doubtless authentic source of that fascinating bit of history.

Roentgen, it appears, in a moment of pardonable abstraction, had placed a still active tube upon a book he had been reading in his laboratory, and

left it there whilst attending to matters elsewhere. Serving as a book-mark, a flat key of ancient design was lying within the volume, and, either by accident, or possibly so placed for additional protection from daylight, a loaded plate-holder was beneath the book. With others, this plate-holder of mighty omen was used on a photographic expedition the same day, and development of the plate it contained, revealed the easily identified shadow of the key. Perplexed by this weird puzzle, he sought assistance in its solution from the youths of his class, with no success. Which is hardly surprising, since the student with the correct answer would have furnished thereby a clear title to fame. Theory having failed to help him, Roentgen attempted to solve the mystery in a practical way. Remembering the precise positions of the tube, the book and the novel marker, and the holder, he carefully re-set the stage, and the actors in the little drama were made to perform their parts again. What his emotions were on once more beholding the outline of the key on a plate that, this time, had been exposed with such deliberation, can be imagined but faintly. It is sufficient to know that with this ghostly key a door was unlocked leading to a discovery that proved to be one of the most outstanding in the history of science; for the intensive investigations which followed had their exceeding great reward in the revelation of the eighth day of November, 1895.

Early in the following January, Roentgen read a paper before the Physico-medical Society at Wurzburg. It was modestly entitled "Concerning a New Ray". Whatever his inner emotions might have been he presented it with the same subdued, matter-of-fact delivery, as if his message concerned merely a new style of test-tube, or a new method in conducting some minor investigation. At the conclusion of his address, the venerable anatomist, Von Kolliker, was invited by Roentgen to place his hand behind the screen. "Never," says one who was present, "will the thrill of that first glimpse of the living skeleton be forgotten." Both the lecture and the demonstration that confirmed its amazing import, created a profound impression, and prolonged applause greeted the discoverer. Roentgen entered that historic meeting, an average German professor, with little more than a local reputation; he left it to take an honored place among the brilliant names in the boundless realm of Science.

BIOGRAPHICAL

1895 — 1923

ROENTGEN became famous over-night. All around the world, echoed and re-echoed, the applause that greeted him at the conclusion of his history-making paper. Nor could his sincere habitual modesty, nor his love of the quiet, unobstrusive activities of university life, hide this simple, lovable man, from the dazzling glare of the publicity he disdained. Not that he lacked appreciation of the honors that were so lavishly thrust upon him; he accepted them graciously. But his nature found its highest happiness in the quiet life of his home, the friendship of kindred souls, and the absorbing work of the laboratory. Even in the latter field, his best results were obtained, when he was absolutely alone. Enthroned securely at the very peak of renown, this elevation seems to have been regarded as the penalty, rather than the reward of his labors.

Among the first to recognize the rise of this new and luminous star in the firmament of science, was William II, Emperor of Germany and King of Prussia. Roentgen was summoned to the royal palace at Potsdam, dined in state, spent the evening in conversation with his Imperial host, demonstrated his discovery, and left at midnight, decorated with the Crown Order of the Second Class. Ludwig, prince-regent of Bavaria, bestowed upon him the Knight's Cross of one of the Bavarian orders, a decoration which carried with it the privilege of prefixing his name with the coveted particle "Von". A government decree made him "Excellency". Wurzburg conferred upon him the honorary degree of Doctor of Medicine, and re-named a boulevard of the city in his honor. His portrait was placed in the Physical Institute, a tablet unveiled, and his laboratory has become a Roentgen museum. He had the rare distinction of having a striking monument erected to him, during his life-time. It stands at the approach to the Potsdam bridge in Berlin, close to similar memorials to some of the greatest names of the Fatherland. In 1901 he was awarded the first of the Nobel prizes for Physics, "in recognition of the exceptional services rendered by him in the discovery of the special rays which have been named after him." This award was generously donated by Roentgen to a society in his native land, established for the encouragement of scientific research. Columbia University gave him the Barnard medal for the most outstanding discovery over a period of years; London honored him in similar ways. Both the Bavarian and the Prussian Academies of Science elected him to membership. Laurels, indeed, were showered on him from the ends of the earth.

Yet beneath this deluge of acclaim, Roentgen remained unspoiled. Fame could not intoxicate him; eulogy brought but a smile. He continued to live his accustomed simple life in Wurzburg; remained faithful to his students and old associations, declining the flattering offers from Berlin and elsewhere that sought to lure him away. Never was he known to have displayed a

thirst for money, but, on the contrary, persistently refused to profit financially from the results of his discovery. He would not limit its progress or usefulness by any patent or monopoly in his own favor, or in that of anyone else. His happiness over the golden revelation was expressed by placing the new-found treasure without restriction, at the disposal of all—a thank-offering. For, as he with heartfelt sincerity expresses it, the German professor enjoys so rich a support in his work through state aid in the matter of good laboratories, in the free disposal of his time in his highly favored position, that he rejoices in any opportunity to show his gratitude.

An incident related by a former student under Roentgen in his Wurzburg days, illustrates in an eloquent way, the very modest ideas of the scientist in regard to financial matters. At work in one of the laboratories of the Physical Institute this student noticed on one of the benches, a scrap of paper covered with Roentgen's script. It proved to be the draft of a letter addressed to some manufacturer of scientific equipment. To this man he had written, that, unless the tubes he required for experimental work could be produced for the equivalent of five dollars each, he would have to build them himself.

Twelve very happy years of life at Wurzburg came to an end in 1900, when, in compliance with the urgent desire of the government, he accepted the call of Munich to become director of the Academy of Technical Physics at that university. In this stately capital of Bavaria, with its magnificent squares and gardens, its imposing public buildings, and famous library, Roentgen spent the remaining years of his life.

Practically unlimited freedom was given to him in the arrangement of his work at Munich. He had left the rapidly expanding application of the x-rays, in their various fields, to the development their own merits had stimulated, and resignedly turned again to his own unobtrusive and seemingly thankless realm of activity. He was not a brilliant lecturer, and was invariably nervous, particularly at the beginning of his address. His special lecture, given annually for beginners, more especially for those commencing the medical course, while carefully prepared, was not popular, because his listeners deemed it too difficult for them to assimilate. Teaching in his own laboratory he was much happier, for in that congenial atmosphere he felt natural and at ease.

Although frequently invited, Roentgen rarely attended learned associations or conferences, because of a reluctance to discuss scientific matters about which he had not yet formed clear and definite ideas. In his criticisms, it was his habit to label as "unlaid eggs", any premature communications on the results of research.

Recreation at this time was found in frequent trips to the mountains that always fascinated him. In hunting also, he found keen delight, and that he might easily indulge the sport the governors of the nearby province of Weilheim bestowed special privileges upon him, making him an "Honor" citizen. Both he and his wife—they had no children—were members of the

Protestant church. Among intimate friends were Professor Georgii, who created the life-like bust of Roentgen, unveiled in the Lichthof of the University of Munich, on the 27th of July, 1928, a photograph of which is reproduced herein; Professor A. Summerfeld, still on the university staff at Munich, in whose career Roentgen was keenly interested, and Professor and Mrs. Boveri. A professor in her own right, the widow of Doctor Boveri now teaches zoology in the Women's College at New Haven.

Despite the phenomenal measure of success which came to him, a wistful note of sadness crept into the later years of his life, for even the gentle soul of Roentgen did not escape calumny. Envious tongues circulated a baseless story imputing the discovery of the x-ray to the work of an assistant. This slander, as it well might, seems to have embittered him, forcing him more and more into a closer silence and solitude. With almost equal cruelty and in the face of incontrovertible facts, a fellow-countryman, in an article on German intellectualism, published a false and contemptible statement that Roentgen was mercenary, "selling his discovery to the world for what it would fetch."

Great sadness came upon him, too, with the outbreak of the First World War, for the early successes of the Central Powers could not deceive him as to that inevitable outcome he forsaw with startling clarity. Withal, he was a loyal German, trusting the wisdom of his country's rulers in simple faith. When, in October, 1914, the notorious declaration of the ninety-three intellectuals was given to the world, he was one of the signers. Nor did he, as so many of them did, repudiate this document at the close of the war, explaining that they had signed it hurriedly, or without grasping its import.

As the years wore on, he became a sad and lonely old man. In the excitement of the war little sentiment could be spared from that vast wave of enthusiasm and sympathy that went out to the fighting-men and their leaders. Even the seventieth birthday anniversary of the man whose genius had done so much to ameliorate the lot of the battle-stricken, was almost forgotten, Summerfeld wistfully notes. A new and strange generation was growing up around him, amid the dark passions of a colossal world conflict, and with loved friends for the most part dead, little of the brighter side of life remained for him. A final glimpse of him at the university is provided in the description given by a witness of a meeting between Roentgen and Hindenburg, when the "two men who have done the most for Germany", shook hands. In 1919 he resigned his chair and retired to a village suburb of Munich. Shortly afterwards a bitter blow was received when his wife, with whom he had lived so happily, passed away after a lingering illness, throughout which he had acted as a faithful, self-sacrificing nurse. Tormented by the infirmities of age, he survived her for three years, the weary days being brightened now and then by dreams of the lofty peaks he was never to see again. He died on the 10th of February, 1923, at the age of seventy-eight, the immediate cause of death being ileus induced by a malignant growth in the lower bowel, of which he was unaware. His death occurred in the home of the widow of Professor Boveri. On the 13th, his body was cremated at the Ostfriedhof

cemetery, Munich, and his ashes repose in the cemetery of Geissen, in which little town he had spent some of the most peaceful years of his life.

Happily a published report that Roentgen died in poverty, has been contradicted from an authoritative source. While far from rich, his circumstances were such that the brief years of his retirement were spent amid all the reasonable comforts of life.

So he sleeps, careless alike of eulogy or vituperation. He blessed the world with an imperishable boon, and his name liveth for evermore. Monuments of stone and bronze commemorate his worth, but the greatest of all memorials are the countless, thankful hearts, whose sufferings have been made lighter by the ministrations his discovery made possible.

Without hesitation Roentgen may be classed as one of the greatest and noblest figures of his generation. Of no profound scholarship, in the conventional sense of that term, he belonged to that type of man, says Sommerfeld, "who, without Latin and Greek, become great." Even so, did Shakespeare. "Like Faraday", says Garrison, "he was no mathematician, but a wonderful stimulator of capable youth; a midwife of mind."

His genius—nor is there any exaggeration in the term—found its outlet in the empirical, rather than the theoretical realm of science, and his dogged patience, excelling accuracy and precision in practical research, have made him a classicist in this field. Proof of this is furnished in the fact that within the compass of his three brief communications regarding the physical properties of the rays he revealed, there is a comprehensiveness which approaches finality. Laue's discovery of their wave nature, fifteen years later, was the first important addition to the knowledge of the physical side of the phenomenon.

Completely overshadowed by that adjective-exhausting revelation of the x-ray, his achievements in other branches of physics have been almost forgotten. Yet he published many scholarly treatises on capillarity, electromagnetics, and many other subjects, embracing even that seemingly foggy zone of the theory of relativity. These contributions, says Wein, his successor to the chair at Munich, would have given him a notable standing among the great physicists, apart altogether from the immortal discovery which made him a Columbus among the pioneers of science.

A mighty man of achievement, a modest and lovable character, he has richly earned the reverence and admiration of all mankind; while to the professional radiologist whose science he founded, the wonderful patience and thoroughness of his methods of working stand revealed for all time, a challenge and an inspiration.

ACKNOWLEDGEMENT

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WILHELM KONRAD RONTGEN

Some Advances in the Science of X-Ray

During the Past Decade

By SISTER MOONEY, R.H.
Hotel Dieu Hospital, Cornwall, Ontario

ONE hears a great deal about electronics these days. Electronics —the control of the power of the minute electron by which science has extended the range of the intellect and senses to a degree undreamed of in history. It would seem that in this day we are being vouchsafed an intimate glimpse, albeit faint, infinitesimal — of the surpassing creation which sprang from "the depths of the riches of the wisdom and of the knowledge of God." Truly, "how incomprehensible are His judgments and how unsearchable His ways." Astronomers, calculating by electronics, can measure iron in the dust of interstellar space. The electron microscope opens breathtaking vistas in the microscopic world! Science can now magnify the image of a mosquito larva's windpipe; photograph the influenza virus; examine microbes that weigh only a few quadrillionths of an ounce. By this magic tube, which may vary in size from that of a walnut to huge affairs 25 feet long, the music and pageantry of the world flash through space in the twinkling of an eye; two million shades of colour may be detected; ships are docked; power circuits synchronized; traffic counted in tunnels; rolls reversed in steel mills; food sterilized; air-field beacons lighted; crystals analyzed — Electronics!

X-rays, too, are electronic in origin. It was while experimenting with a vacuum tube on the conduction of electricity through gases that Wilhelm Konrad Roentgen made his epochal discovery. X-rays are produced by impinging a stream of electrons, travelling at rates around 100,000 miles per second, on a metallic target.

What is an electron? An electron is an invisible particle of pure negative electricity. The world of matter is composed of molecules. Molecules, in turn, are a combination of the 92 established elements, or kinds of atoms. Atoms are made up of protons and electrons. Protons are tiny, positively charged particles of electricity which, so far, are indivisible. These, in combination with neutrons having no electric charge, and the possibility also of other particles like the mesotron and the neutrino, form the nucleus of the atom around which the negatively charged electrons revolve as the earth and planets revolve around the sun. To quote A. S. R. Ruthen: "There is a relatively large amount of space around the proton. This is an important concept because it helps us to understand how the electrons can oscillate within the atom and produce the various rays. If you imagine a large auditorium with a chandelier in the centre and a few flies buzzing around in circles, you grasp some idea of the construction of the atom."

These ever-whirling electrons can be divorced from the influence of the nucleus and put to useful work through the amazing medium of the vacuum tube. Following the law of conservation of energy, when electrons move towards a positive charge under the

force of an attraction which exists between unlike charges, they will acquire kinetic energy. When these electrons are stopped, by the target in an x-ray tube, for example, their energy of motion is changed into other forms. Most of it will appear as heat in the bombarded material but some of it will be changed into electromagnetic radiations — or x-rays. We see, therefore, that x-rays are an unique type of energy and, being energy, they can do work such as producing chemical changes on an x-ray film.

Since the discovery of x-rays just fifty years ago, it is practically unbelievable the stupendous strides that have been made in this science. Formerly considered as an instrument for use almost exclusively in the medical world, latterly, it has become an increasingly important adjunct to the industrial world.

Welded seams in pressure vessels, tanks and similar equipment are subjected to x-ray inspection to determine the presence of internal defects. Before the advent of x-rays in industry thousands of man-hours were wasted on precision machining of castings that were eventually found to be faulty. Faulty castings can now be discovered before machining commences. This has speeded up production and has saved untold money and man-hours.

To quote E. M. Gingerich and H. J. Rowe: "The x-ray has proved to be a valuable aid in overcoming casting difficulties in the foundries of the Aluminum Company of America. It has been employed both in determining the foundry technique which will give the most satisfactory casting and as a production check in order to maintain the original standards.

"In a number of cases the x-ray has been included as a part of routine inspection. The x-ray, of course, is not a foundry 'cure-all,' but when properly used, and the knowledge derived from it properly applied, it becomes a very handy tool.

"The increasing use of complex alloys and patterns of intricate design are taxing the foundryman's skill to produce sound castings. Up to the present time, most alloys which develop high physical properties show a tendency toward greater internal shrinkage in castings.

"Defects caused by these tendencies can be more easily detected by x-ray than by any other means. By proper corelation of x-ray examination and casting technique, such defects can be more readily eliminated."

Specifically, the radiographic method of examination is capable of showing, in any section accessible to x-ray, defects — shrinkage, tears, cracks, piping, gas cavities, inclusions and other interruptions to the internal continuity of the metal — as small as one to three per cent.

Together with the recognition of the wide field for the industrial application of x-ray came the necessity for development of specific apparatus. Thus a series of specialized units having transformers, tubes, controls and mountings all designed expressly for industrial services came into being.

One of the most important advances was the development by Dr. W. D. Coolidge of the principle of enclosing the x-ray tube and transformer in a single hermetically-sealed tank. This provided shock-proof and climate-proof operation; it eliminated the need for high voltage cables; it made possible unusually compact design and greatly increased the range of service of industrial x-ray apparatus.

There are a number of basic units available, such as the Stationary Jib Crane with a manual or motor-operated

raising and lowering mechanism; the Mobile Jib Crane with electric drive raising and lowering mechanism; the unit mounted on a mobile chassis equipped with pneumatic tires. Then there is the Overhead Bridge Crane of standard design which provides lengthwise and crosswise travel of the complete unit plus vertical travel range of the tube head. Experimental radiographic units, designed for specific uses, for example, radiography of thin, light metal sections, have also been constructed.

Hailed as an "industrial development of the first magnitude," is the Million-Volt Industrial X-ray Unit introduced in October, 1941. Its development provided a full answer to imperative defence requirements that demanded an accurate, high-speed method of inspecting large castings, pressure vessels and weldments. Its use insures the saving of time and labour with the guarantee of excellent radiographic results.

The principal feature of this new unit is the fact that at one million volts it operates at two and one half times the voltage of previously available units. Then the development of a hot cathode, multi-section tube permits the production of a copious and consistent source of electrons. The tube is inserted within the transformer which affords the necessary protection from high voltages. Air and moisture are completely removed from the transformer and tube housing and is replaced with Freon, a gas of unusually high insulating properties, which permits great reduction in the size and weight of the unit.

The complete million-volt industrial unit is housed in a tank 4 feet in length and 3 feet in diameter, but the projections of the concentrically mounted x-ray tube and other parts increase the overall length to about 6 feet. The unit weighs 1800 pounds and is sufficiently light and flexible as to be readily moved about by means of a crane for the examination of industrial welds and castings which may weigh as much as 60 to 90 tons. Lest you gain the impression that slightly more than three quarters of a ton hardly represents a portable unit, it is well to remember that this represents the complete x-ray unit, and further that only a few years ago, a multi-story building was required to house an 800,000-volt medical therapy unit; that an 800-kv multisection tube operated in air was 14 feet long and one foot in diameter, while the million-volt tube operating in an atmosphere of Freon, has an insulating envelope 30 inches long and 3½ inches in diameter.

Another field in which the x-ray inspection method is being used with growing demand is in the food factory. Here, the need for dependable and thorough examination to detect foreign materials which may have found their way into food products is easily seen. Not only is the detection of foreign material made possible by x-ray, but in the case of whole vegetables; for instance, potatoes or carrots, hollow hearts may be detected; in whole fruits, the discovery of frost-damage, crystallization, blossom-end decline, etc., is of great value. Bone chips in meat or poultry for packing; shells in oysters and clams in bulk; and many, many other such unwarranted conditions may be determined by x-ray inspection.

In contrast with radiographic examination of welds and castings in the metal industries, where the permanent x-ray record on film is studied, application of x-ray to food inspection is confined largely to the fluoroscopic or visual method. Usually the product to be inspected is carried on a conveyor

belt over the source of x-radiation and under a fluoroscopic viewing screen. Suitably protected, the operator or inspector sees on the screen the image of the material being carried on the conveyor belt. With many packaged products there is sufficient definition to allow the inspector to detect a shortage in the fill of the container, in addition to discovering foreign bodies that may be present. To indicate the possibilities of inspection of raw materials, an example may be drawn from the fact that in the examination of nuts or beans, it is possible to differentiate between these and such foreign bodies as stones or dirt balls even though the latter may simulate the former in size and shape.

Equipment of approximately the same type is being used in the examination of plastic molded parts to check the position of metal inserts; in the shoe industry to examine shoes for the position of nails, lasts, etc.; in wires and cables to locate breaks in wiring and centring in insulation; to detect porous interior in insulating bricks; to locate loose parts in cartridges, etc. In effect, visual x-ray inspection gives the examiner the remarkable opportunity of looking through instead of at the material in question.

Nor is the industrial field the only one which x-ray has invaded. Mutation by radiation in the sciences of agriculture and horticulture has intrigued research workers with the fascinating possibility of creating new varieties of vegetables and plants, or vastly improving the old ones. Nor is the progress already made insignificant. In California, for instance, seeds treated by x-rays have resulted in two greatly improved variants of cotton. The humble potato has faired well under x-ray treatment—x-radiated tubers cluster about the roots like grapes and are larger and more choicely flavored than ever. New varieties of tobacco have been literally bombarded into existence!

Flower lovers have been presented with two new calendulas in which the x-ray was the all-important factor in their creation. This is a bit of their history, as related by Mr. Percy Ghent: "Back in 1933, Dr. Goodspeed, of the University of California, an authority on genetics in its relation to horticulture, exposed calendula seeds to x-ray with an experimental dose not revealed. Two of the varieties so treated were Sunshine and Radio calendulas. Out of the seed of Sunshines, a new flower, Glowing Gold, was evolved; and from Radio came Orange Fluffy. Both varieties are quite distinct, are free bloomers and promise to become garden favorites. After they had been created they were watched and tended carefully for six years before being placed on the market. In that lapse of time the permanency of the strains was assured.

"Radiation and the drug colchicine which was developed from the autumn crocus, are the two successful methods thus far used, for creating mutations more or less at will. Colchicine is known to increase the chromosome number in plants, and to intensify or destroy some of the hereditary traits of the flower. X-rays on the other hand, are thought to smash the genes and break up the chromosomes in the seed, so that the next generation, so to speak, "goes crazy," and anything in the way of a change for better or worse may happen. Experiments have proved, certainly, that the changes brought about by radiation are more definite and radical than those induced by colchicine.

"Lying in the centre of the cell nuclei, the chromosomes constitute the

mystic, invisible element which controls heredity in the plant. Hence changes or modification of this element are manifested, eventually, in future growth. Of necessity, much is left to chance and plain luck in this strange bombardment in which invisible rays are fired at an equally invisible target. For the structural, electrical and chemical principles alike behind this attempt to hasten the evolutionary process, and to create new patterns of life in grains, grasses, flowers and fruits, are as yet but dimly understood."

As some poet or author once said — "We live on a small bright oasis of knowledge surrounded on all sides by a vast region of impenetrable mystery."

One of the most fascinating branches of research is the analysis of crystalline substances by x-ray diffraction. All solid materials are composed of an aggregate of crystals, varying in size from the most minute which cannot be seen with the most powerful microscope, to extremely large ones. As an example of the extreme size to which crystals may grow, pure quartz (silica) has been quarried in trainload lots from a single crystal in the Ural mountains, for many years, and the end is not yet in sight.

As the nature and behaviour of a substance depends upon the arrangement of its atoms and molecules within the crystal, a knowledge of this arrangement is of the greatest practical value in industry. Even non-crystalline materials, as liquids and gases, or "amorphous" solids in which the atoms and molecules are not arranged in the definite, regular manner required to form a crystal, give x-ray diffraction patterns.

When any material is subjected to the methods of x-ray analysis, an "x-ray diffraction pattern" is obtained. This pattern, recorded on photographic film, is an image of the radiation as it is modified by the object. Every chemical compound has a characteristic diffraction pattern which cannot be confused with any other. This is the basis for the most important practical application of x-ray crystal analysis, that of identifying unknown substances, and of analyzing mixtures in terms of chemical composition.

The application of this phenomena is practically unlimited. For example, it is being used in Metallurgy to determine the composition and structure or alloys; the effects of annealing and other thermal treatments on metals, etc. In Chemistry: to note crystal structure; ionic groupings in substances; identity of synthetic and naturally occurring materials; study of lubrication and lubricants; study of changes taking place during the ripening of cheese and other dairy products, etc. In Mineralogy, its uses are legion. In the Textile and Fibre industries it furnishes a scientific method of classifying cotton, silk, wool and other natural fibres. Incidentally, x-ray diffraction studies on collagen fibres (catgut) have resulted in enormous improvement in the strength and controlled digestability of surgical ligatures and sutures.

Its application in Physiology, Pathology and Biology are of quite recent development and are not as yet very generally used. Considerable research work is being done on the study of differentials between normal and pathological tissues; on the effect of disease on tissues, for example, bone structure changes in rickets; on the identification and classification of mineral deposits in organs, for example, gall stones, siliceous deposits, etc.

In effect, the possibilities of x-ray diffraction studies are unlimited. To

quote Rev. Joseph J. Carroll, S.J., Ph.D.: "The study of x-rays as to particle and wave characteristics, has broadened our horizon. A new world of research has been opened up, and new outposts have been pushed farther into the uncharted field of Nature."

Now, let us take a glimpse at some of the advancements in the medical field. For the last two decades, the main trend has been towards standardization of results; or, in other words, the repetition of given densities for specific parts of the anatomy, on the finished film. So many factors enter into the production of a radiograph, that one is tempted to despair in an effort to produce consistent results over a period of time.

When the sputtering mechanical rectifier was replaced by the noiseless and more stable valve-tubes, a forward step in electrical factor control was achieved. This was followed by more efficient filament stabilization which managed to preserve a given filament output from the vagaries of supply lines. Then pre-set milliamperages with direct reading kilovolt meters which automatically compensated for expected voltage drops, together with adjustable auto-transformer input regulators to meet the hour to hour changes in line voltage; and hair-line adjustments of pre-set filaments have all been brought forth in recent years to aid in the drive toward standardization of results.

X-ray tubes have also advanced a long way from the days of the temperamental gas tubes which had to be seasoned to such and such a performance, with a wary eye on the thermometer and the barometer! Present day tubes may be regarded as stable. Even dissipation of generated heat by the immersion of the tube in oil, better electrode materials and improved evacuating methods have brought the x-ray tube to a summit of excellence. In the manufacturing process, nearly a perfect vacuum is the ultimate ideal, and although this is unattainable at present, the vacuum in the modern tubes is very high, there being approximately a trillion (10^{12}) molecules per cubic inch still remaining in the tube.

In the development room, blended hot and cold water to given temperatures, accurate timing in processing, better safe lamps and non-reflecting wall paints have made the present day, well-appointed processing room a home of mathematical precision. There is on the market a unit known as the Pako Filmachine which makes possible the preparation of finished films practically "untouched by human hands." The loaded hangers are placed in one end of the machine and emerge at the other completely processed and dried. The films pass automatically through the developing solution for a prescribed period of time, thence through a stop bath, fixing bath and wash tank and into the drier. The output is one film per minute. It has found extensive use in busy industrial laboratories.

However, in spite of all these improvements, the human element, until recently, has stood squarely in the way of absolute standardization. In the x-ray room, the little girl with the paper-thin skull and the negro whose cranial thickness may be enormous, can, and often do, have identical outside skull dimensions. Bone structure rich in calcium may follow heavily decalcified skelata. An arm in a fresh, wet plaster cast may precede another in a thoroughly dehydrated one. A carefully machined magnetic contactor with synchronous or stabilized timer may be capable of a miss in the order of one

impulse, one one hundred and twentieth of a second! A small difference, to be sure, and yet that one impulse on a twentieth of a second exposure, means a difference of well over 15% in film density.

But now, even these seemingly invincible routine-spoilers are being rendered impotent by a recently developed instrument called a photo-timer. This device, used principally in photo-fluorography at the present time, is completely automatic. The technician is required merely to position the patient, turn on the x-ray machine at suitable kilovoltage and milliamperage settings, and close the exposure switch. The photo-electric timing mechanism, by its inherent design, terminates the x-ray exposure at the instant when the film has received the proper quantity of radiation to insure correct exposure. The measurement of chest thickness, the calculation of exposure factors, the adjustment of kilovoltage, milliamperage and exposure time are entirely eliminated. When the photo-timer becomes available for routine radiography it will be quite possible to x-ray in succession huge Igor Roussouski, who weighs an even 220, and little Mary Smith who tips the scales at 96, and produce identical films by the mere pressing of a button! One more step towards ultimate complete standardization.

Another interesting feature in x-ray advancement is the perfecting of equipment which makes possible the production of radiographs showing detail in only one thin lamina of the object being radiographed — in other words, the third dimension. The general term applied to this type of examination is Tomography. Several names have been given to variations of the tomographic method — Stratigraphy, Serioscopy, Planiography, Laminagraphy, etc. The main requirements of each, however, are: (1) all detail in the plane to be examined shall be shown on the film, and (2) all detail in unwanted planes shall not be shown on the film or, in other words, blurred-out.

These requirements are achieved by moving the source of x-rays, that is, the x-ray tube, in one direction, and at the same time, moving the film in the opposite direction in a constant ratio by means of a connecting linkage which rotates about an axis lying in the plane to be examined.

In tomography the diffusion of all the structures save the particular plane to be examined is brought about by linking the movement of the tube, grid and film about this plane. The tube and bucky are joined together by a pivotted metal bar and by this means are given opposite movement about an adjustable axis.

In serioscopy, the films are kept stationary and the image of a given plane is displayed according to the tube shift. When the finished films are superimposed, one can, with a controlled sliding movement of the films, focus on all planes from the one closest to the film to the one farthest from it.

The laminagraphic principle is similar to the tomograph in linking the movement of the tube, grid and film, but with additional movements to give extra diffusion to the planes other than the one selected to be in focus.

Perhaps one of the greatest single improvements in x-ray in the last ten years, from a public standpoint, has been the use of miniature films in mass x-ray chest surveys for tuberculosis. While the efforts of tuberculosis workers have resulted in a marked reduction in the number of deaths annually from this disease, pulmonary tuberculosis still constitutes a major health problem.

It is generally agreed upon that x-ray examination of the chest is one of the best means of detecting early pulmonary tuberculosis. Dr. Thomas Parran, Surgeon General of the United States Public Health Service, has said: "Tuberculosis can be eliminated as a public health problem in a measurable time if we use the x-ray to locate every case — and I mean every case, and if we provide adequate facilities and personnell to isolate and treat infectious cases. For the first time, our technological progress makes this goal practical."

While the dependability of x-ray findings in this regard was established long ago, the high cost of the material involved in the use of conventional size x-ray film for chest work, 14 by 17 inches, precluded the possibility of financing extensive surveys.

This objection has been overcome by the use of small size films in Mass Survey methods of which there are three: the roentgenographic paper method, and the two fluorographic methods, one using the 4 by 5 inch film and the other, the 35 mm. film. There are advantages and disadvantages connected with each method but the indisputable value of any mass survey is that it serves to find and segregate, in a way that would not otherwise be possible, a number of persons with active tuberculous lesions, and a further number of inactive cases which may lead to the active ones that are the source of their infection. Furthermore, in every survey, a number of non-tuberculous conditions, requiring treatment, are discovered.

One disadvantage of the 4 by 5 film is that it is too large to use as a roll film and must be used as cut film. It can, however, be viewed for diagnostic purposes directly. The 35 mm. film, on the other hand, can be made into a roll film but must be enlarged for viewing purposes. In view of this considerable research has been done and a compromise has been made. Fairchild has developed a new camera of 70 mm. size. This incorporates the advantages and disposes of the disadvantages of the other two sizes. Radiologists and manufacturers have agreed that this size is the one of choice taking all factors into consideration. However, the 4 by 5 size will be retained for cases where high diagnostic fidelity is required and the speed factor not of undue importance.

Granting that these new methods of mass examination are of paramount value, it must be borne in mind, that the checking of results and errors by conventional radiography is required. It is comparable to a qualitative analysis in a clinical laboratory which, when indicated, must be followed by a more accurate quantitative estimation.

Fluorography, synonymous with Photo-roentgenography, Fluoroscopic Screen-Photography and Indirect Radiography, is a method, as the name implies, of photographing the fluorescent image.

While Fluorography is almost as old as x-ray itself, having been attempted as early as 1896 in England by Bleyer, it failed at that time and subsequently due to the lack of efficient x-ray and photographic equipment. To-day, due to the accomplishments of research along these lines during the last few years, we have at our disposal fast lenses and greatly improved screens and film. We have x-ray machines of adequate output, tubes with increased capacity, electronically controlled timing mechanisms, etc., so that films of good diagnostic quality are now possible.

These mobile x-ray units are completely and practically equipped from

the Photo-roentgen apparatus itself down to padded leatherette seats in the dressing rooms. The complete procedure, including the processing of the films, is carried on in the bus.

Some of these units are so constructed that the x-ray apparatus can be removed from the bus with relative ease and set up in a large factory, school or hall where the number of people to be examined and the time involved would justify this method of conducting the survey.

The question that naturally arises in one's mind is — are mass surveys, using miniature films, reliable from a diagnostic point of view? Dr. Hollis E. Potter says: "Whenever a fluoroscopic or fluorographic short-cut is contemplated it is only right that the conservative internist and the conservative roentgenologist reserve judgment until proofs of diagnostic accuracy are available. It is my impression that miniature fluorography at its best now offers a definite short-cut in technique and unit cost without an appreciable sacrifice in diagnostic accuracy."

One more forward step in the science of x-ray must be mentioned before the termination of this paper and that is the million-volt medical therapy unit. This remarkable achievement, initially engineered for war industries, now benefits medical science by assuring maximum effectiveness and safety in use in the treatment of diseases amenable to radiation therapy. The unit differs from its predecessors essentially in the new sealed-off x-ray tube which makes possible unique flexibility of application.

Considering the diverse developments, many of which have not even been mentioned, in the science of x-ray during the past ten years, who can say what another decade will bring? Dr. W. R. Whitney, first director of the General Electric Research Laboratory, said: "We are always supposing we have exhausted our knowledge in many directions. Discoveries are not terminals — they are fresh starting points from which we can climb to new knowledge."

Another great man has said: "The knowledge of creatures, the partial, incomplete, fragmentary knowledge that we acquire here on earth, bears no proportion to the vast capacities of the human mind, made to possess the fullness of truth in heaven. A raindrop is large enough for the pirouetting of an amoeba, but it will scarcely suffice for the gambols of a whale."

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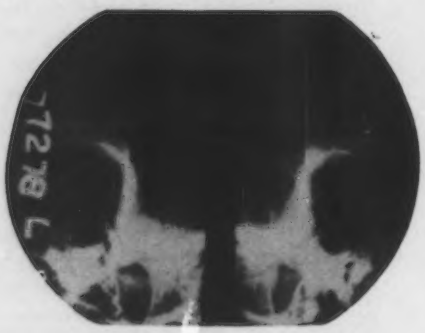
An Anterior-Oblique Projection of the Optic Foramina

By NORMAN HURST, R.T.
Victoria General Hospital, Halifax

THE reader no doubt realizes that there are many techniques offered for the radiographic examination of the optic foramen. To the best of this writer's knowledge, all are based upon a postero-anterior oblique projection. This projection has, it seems, been accepted as standard for many years.

This writer has employed an a.-p. oblique posture for the past year or more with results as illustrated on this page. This method has produced uniform results over this period of time and is now preferred, for the technique is speedy and perhaps a little less uncomfortable for the patient.



A-P oblique, 56 K.V.P. 125 M.A.S.
44 ins. dist. cone, with Bucky

Technique:

The patient is placed upon the Bucky table in the supine position, the head and trunk being aligned with the table centre line.

Assuming that the left foramen is to be rayed first an opaque film blocker is placed to the left of the table centre line and of course under the left orbit. The head is now rotated to the right until the median line is 38° right of perpendicular, and then tilted back until the canthus-auditory canal base line is 30° from perpendicular. The tube is kept at centre for all exposures, the rays to be directed through the orbit to the centre of an 8 x 10 casette which is placed transversely upon the Bucky tray. Suggested exposure factors are the same as for the lateral skull with the addition of 25 to 50 M.A.S.

The examination of the opposite side, in this instance the right side, merely means rotating the head 38° to the left of perpendicular and transferring the film blocker to the opposite side of the centre line of the table. This exposure is made on the same film, or, as stereos are usually requested, employ two films for the four exposures. Care will have to be taken in the matter of tube shift, the same sequence being necessary for both sides.

Summary:

From the above instructions the reader may assume that this technique is complicated. This assumption is not quite correct. The a-p projection is thoroughly practical and the end result is equal in quality to the better known projections.

Even if not used routinely, there are many occasions when an alternate posture may be employed to good advantage, especially when we are confronted with an infirm person whose ability to co-operate is limited. Therein lies the value of the above described technique.

Finally, it should be recognized that every technique for the examination of this part calls for exactness in all posturing details. Any deviation from the prescribed lines of angulation can only result in misrepresentation of the true contours of this small canal.

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The Photo-timer

By K. E. HALL, Toronto
Technical Service Dept., Victor X-Ray Corp. of Canada Ltd.

ONE of the greatest difficulties in mass radiography of the chest (see reference 1) for tuberculosis has been the variation in density from one patient to another. In these surveys, chest measurement and certain other physical factors, such as the patient's weight, age and tissue development, have been the principal guides from which the proper technical procedure has been derived. Unfortunately, such information is oftentimes misleading, for even though two patients may have the same chest measurement and other outward physical similarities, their radiographic opacities, so-called, may be quite different. Then, too, there is the personal factor on the part of the operator; no two technicians judge the patient in exactly the same manner. These factors tend to produce certain variations in both the density and the quality of the finished radiograph.

In order that as many variable factors as possible be reduced to what may be called a common denominator, there has been developed a device more commonly referred to as a photo-cell timer (see references 2, 3, 4, 5, 6), which is adaptable to photo-roentgen units (see references 7, 8) for mass surveys of the chest. With this device, radiographs of comparatively uniform density can be made by simply closing the exposure switch, the exposure being terminated automatically when the film has received sufficient radiation for the desired density. This operation is independent of the kilovoltage and milliamperage applied to the x-ray tube and the thickness of the chest being examined. The density of the film thus produced can be maintained within acceptable diagnostic limits regardless of the thickness of the patient, not to mention the idiosyncrasies of the operator.

The basic principle of the photo-cell timer depends upon the action of a photo-electric cell or photo-cell, a device which passes current in proportion to the amount of light falling upon it. Its action is similar to photographic exposure meters used by camera enthusiasts for measuring light intensities.

In operation, the photo-cell, with its associated optical system, is placed in the photo-roentgen unit so that a portion of the light from the fluorescent screen falls upon it. When the proper amount of light has been received by the photo-electric cell — and this amount depends upon a pre-determined film density which can be set by the operator — the exposure is terminated automatically. The greater the opacity of the chest, the longer the exposure must be before the light received by the photo-electric cell will be sufficient to terminate the exposure. With the photo-cell timer, precise kilovoltage values are not necessary, for should the kilo-voltage value be set too high for a given chest, the amount of light received by the photo-cell will naturally be greater than if a lower value were used, with the result that the exposure would be automatically terminated in a shorter time, thus maintaining a predetermined density. Be-

cause of milliampere-second accuracy when using this type of timer, it is possible and entirely practical to reduce materially the number of kv.p. steps ordinarily employed for this type of work with a conventional type of timer. For example, only five kilovoltage values for all types of chests are recommended: Approximately 60 kv.p. for a very thin chest; 70 kv.p. for a thin chest; 80 kv.p. for a medium sized chest; 90 kv.p. for a heavy chest; and 100 kv.p. for the extra heavy chest.

The photo-timer is designed for operation between 1/10th and ½ second. No exposures longer than ½ second are employed because the photo-timer automatically terminates the exposure if this value is exceeded, thus protecting the x-ray tube from being overloaded. In addition, it would only be in the rarest instances when it would be necessary, due to the type of patient, to employ exposure values in excess of ½ second.

It must be borne in mind that the photo-timer does not produce radiographs with exactly uniform densities regardless of the condition of the patient. As described above, the photo-timer varies the exposure, depending upon the amount of light falling upon the photo-electric cell. This light is received from a definite area of the fluorescent screen and in chest work this area measures 3″ x 9″ and is located in the upper one-third of the chest, just below the clavicle.

As this area is the basis from which the density of the entire chest must be considered, there are certain conditions of the patient which will produce a density change, not because there is a fault in the timer operation, but due to an increase or decrease in the opacity of the area being scanned. In the latter case, the subject may have either an artificial or spontaneous pneumothorax. If the pneumothorax exists in a portion of the scanned area, the illumination of the fluorescent screen will be much brighter and hence the light received by the photo-electric cell will be more intense, with the result the exposure will be terminated sooner and the overall density of the entire chest film will be reduced. On the other hand, if heavy consolidation be present covering a large portion of the so-called scanned area, then the light received by the photo-electric cell will be less intense and the exposure will be longer, with the result the overall density of the chest will be increased. However, when such conditions are known, an external control on the photo-timer allows for correction. The above conditions are not particularly common, and not to the point that the diagnostic density of the resulting film makes a retake necessary. This density control also compensates for variation in individual preferences of density, changes in film speed, processing conditions, etc.

The advantages of the photo-timer in mass surveys of the chest are many. It not only eliminates the time needed for chest measurements but also the errors which will result from improper measurements. Another difficulty which is overcome by the use of the photo-timer is the wide variation in film densities due to replacement of technicians. Since the density on the film is established automatically, replacement or alternation of technicians may be made without fear of disturbing the quality of the finished radiograph. The use of the photo-timer

tends to standardize film quality between different points of operation. It is well known that line conditions vary considerably from place to place, but with automatic control of density this variable factor is eliminated.

Finally, the function of the phototimer is to allow the radiologist to obtain what he considers to be the most acceptable quality of film more consistently than has been possible with previous procedures. For the technician, the elimination of one of the most serious handicaps in radiography, namely, the inability of even the most highly trained technician to successfully judge tissue density by merely measuring the part or making a guess based upon the physical make-up of the patient.

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The President's Letter

TO all members of the Canadian Society of Radiological Technicians I extend greetings, good wishes, and thanks for the honor bestowed upon me. It is my earnest hope that the season of activities now before us and the years to follow, will be marked by success, progress and good-fellowship in the history of the Society. To bring about this desirable development, I need not remind you, involves much more than the interest and enthusiasm of your president and officers; it is an ideal that can be realized only when the membership at large is equally keen and co-operative.

In the fifty years that have elapsed since the discovery of the x-ray, radiology has become a vitally important branch of medical science. Progress in the mechanical and technical fields of the science of radiology has been amazing, as those of us with long years of service behind us well know. It is in the realm of organization and personnel, perhaps, that we are still more or less in the pioneer stage. Such questions as the educational background of the technician; what constitutes adequate training; where and by whom the theoretical and practical training will be given. These and other problems will have to be met and mastered. And their solution will involve infinite time and patience. Time and patience indeed, will be called for in the settlement of many difficulties facing the Society, now, and for some time to come. But if we use these factors together with constructive ideas and action, all will be well. Toward the Society, its journal, The Focal Spot, and all its activities and ideals, let us all extend interest, help and loyalty.

THOMAS B. HURST.

Post War Rehabilitation

By GROUP CAPTAIN D. C. M. HUME
Toronto

NECESSITY was felt for a scheme whereby ex-Service personnel, both men and women, could be put back into the stream of life in a reasonably permanent gainful occupation after discharge. Furthermore, this restoration to civilian occupation should be at a level which represents as nearly as can be judged the level which the returned person might reasonably be expected to have achieved had he or she not gone into the King's Service during this war. The person coming out of the Service has three alternatives of requirement.

(a) Treatment is needed.
(b) Employment is needed.
(c) Rehabilitation training is needed.

If treatment is needed, the Department of Veterans' Affairs has provision for hospitalization and out-patient treatment as required from which, or with which, may arise pension, compensation or disability cases.

If employment is required, the discharged person goes to the National Selective Service office where as a veteran, he or she, sees the Veterans' Welfare Officer there stationed, who will try to obtain the job sought or the best substitute thereof, having regard to the knowledge and aptitude of the applicant.

If a discharged person decides to take training — and note: the decision is the applicant's, not the department's — he or she comes to 55 York Street, if residing in Toronto, where under the friendly exploration of an interviewer of the Department of Veterans' Affairs the main particulars are gleaned, proof of Service established, and the one and only formal document — W.D.1 — composed, which thereby starts the applicant on the path to obtain training. From the interviewer, the applicant passes to a Counsellor and the Counsellor's business is to analyze the applicant's desires, clarify any haziness of information and advise the applicant to the best of his ability as to what path he should pursue. If the applicant comes with a good idea the Counsellor will help develop it. If the applicant comes with a bad idea the Counsellor will display its objections, but will not throw it out "willy nilly" on the matter of opinion. He may have to declare that such training cannot be given due to saturation condition in the facilities, but even then it is not part of his business to "sell" an applicant any particular line of occupation. It is important that the applicant has as much knowledge as possible of the kind of occupation in which he seeks training, and for this purpose the Counsellor will often refer him to some authority on the trade or business who has volunteered to give precise information about the occupation. Service organizations such as professional institutes can be of great value purely as advisory bodies to any returned personnel who feel that a particular occupation, such as yours — Radiography, attracts them. Applicants again may

Digest of speech given at the Convention Luncheon of the Ontario Society of Radiographers, May 12th, 1945.

come in with no idea of what they want; these are problems for the Counsellor to overcome and should he find himself unable to come to a reasonably positive recommendation then, and then only, at present, are specific aptitude tests involved.

When an applicant has been completely counselled he has nobody else to see until he is about to start training, but his case and proposition are presented to appropriate authorities who decide—(a) that it is a reasonable and proper occupation for this person; (b) that reliable training along the lines requested is available. Up to this moment the matter has been in the hands of the Department of Veterans' Affairs, who is concerned with making the decision as to training. When a decision has been made that the applicant shall be trained, the case is sent down to Canadian Vocational Training, which is a Provincial organization obligated under the British North America Act to control Vocational Training within the Province of Ontario. It does not matter what training has been decided upon by the Department of Veterans' Affairs, it is the job of Canadian Vocational Training to go out and find it. Canadian Vocational Training employs three methods of Vocational Training:

1. The Provincial Government or Municipal Trade Schools, which usually entail no fees.
2. Private or money-making schools which do entail fees.
3. Training-on-the-Job.

All the above in their several ways achieve different results and can be used according to the requirements of the applicants, but the expenses entailed are all charged against the applicant's Rehabilitation credit, or more exactly, whilst the person is taking training no Rehabilitation credits exist; at the end of the training if the cost of same has not equalled or exhausted the total amount of the applicant's Rehabilitation credit, then the remaining portion is available for expenditure in the ways laid down for that form of gratuity. It may be noted here, that the sum of money known as the War Service Gratuity has no part in this plan and is paid to the discharged persons by their appropriate services and can be used or expended in any way they think right, wisely, or otherwisely. But the Rehabilitation credit which is an equal sum in size, is placed to the discharged's credit on the books and can be only expended along certain lines and then under protective supervision of the Department of Veterans' Affairs; this prevents wanton expenditure and money, protects against rackets and sharp practices and conserves the money which can help a person's Rehabilitation.

Under the heading of Trade Schools come those Provincial Institutions, such as the Ontario Training and Re-Establishment Institute, wherein are situated amongst specific schools for the trades designated under the Apprenticeship Act. The objective of these is to produce students previously in ignorance of the trade at the level of entering 3rd year apprentice, after which the progress and placement of the person rests with the Apprentice Board of Ontario.

In these institutions also are certain specialist Vocational Schools which are sponsored by the industry

interested. For instance, there are projected in Toronto at this time a school for the Graphic Arts and a school for the whole field of Hotel and Resort business. Amongst private schools are Business Colleges, Art Schools, Dress Design, Radio, Hairdressing and others, including correspondence schools. It is to be noted that an applicant cannot get a correspondence course unless it is related to his or her daily occupation and then only on the production of a supporting letter from a responsible official of the employer firm to say that the taking of the course will redound to the applicant's credit with the firm. This is done to protect against inefficient waste of money or unjust expenditure for incompleted, inappropriate courses.

In Training-on-the-Job we have one of the best schemes that has come to the writer's notice. In this an applicant having been properly counselled and recommended, it is in view of said counselling, presented by Canadian Vocational Training to a firm or an employer willing to undertake the training of this man in the field approved and to a schedule which has already been discussed and forms part of the agreement made between the Department of Veterans' Affairs and the employer himself. In the case of a man who has no pre-competency for this work it is obvious that he is not worth a great deal of money to the firm at the start, but also that he will progressively improve in value as time goes on, provided that he receives properly the instruction handed out to him. It must be observed here that the arrangement is definitely a fifty-fifty one, and that receptivity and hard work is expected from the Trainee as well as serious positive instruction from the employer. The results to date are most gratifying; there is doubt but that the returned personnel are more mature than their age, more aware of the importance of things in life and much more inclined to equip themselves than the ordinary callow youth entering an industry at the post-high-school level.

In order that a trainee shall, because of his maturity and possibly because of his marital status, be in experience of a reasonable state of comfortable existence, arrangements are available through the Department of Veterans' Affairs for his comparatively low, if strictly appropriate, pay to be built up to a degree controlled by a specified schedule by the Department, and designed to look after the desirable adjustment due to marital status or pensions. But there is an important point here, namely, that the total pay that a trainee receives whilst in training must always be less than the total pay he is going to get from the firm at the completion of his training period. Thus avoiding any recession which would be very bad psychology to allow to occur if avoidable. A trainee therefore starts with a sum of money which is made up by so much from the firm and so much from the Department of Veterans' Affairs grant or benefit, as it is called. As he progresses in his training, which is usually granted for 12 months or such less time as he was in the Service, he becomes of more value to the trainee employer, to whom it is, therefore, suggested that he should pay more and the Government refund less, the man still getting the same total amount. This

process is extended as the training goes on, the firm paying a little more at regular intervals and the Government refunding a little less until finally the man fades into the firm's full employment, trained in their business, in their way and not trained for anybody else. Whatever the man gets is the same total amount all through his training as he gets it all from one source, the employer, the Government refunding the latter as agreed upon in due course. This is a good disciplinary point as the man knows just where to look for his money and for his daily discipline. The man is regarded as an employee of the firm and not a ward of the Government, and if he is not satisfactory in his carrying out of his part of the arrangements he can be discharged like any other employee; likewise should the firm not do their part of the arrangement Canadian Vocational Training which keeps a monthly and parental eye on all training is apt to take him out and put him elsewhere.

Canadian Vocational Training pays particular attention to saving the trainees all money possible from their Rehabilitation credit which when available can be used for such important purposes as helping to buy a partnership, a mortgage, furniture or buying tools of the trade.

In addition to the strictly Vocational Training machinery described so far, there are also facilities which come under the Regional Office of Vocational Training for providing certain academic qualifications, such as Senior Matriculation to those people who lack a few subjects or even all of them and are wishing to take up an occupation which requires this academic standing as a qualification.

The outstanding results of the endeavours to date (which may be taken as having started around August 1st, 1944), are not exclusively due to the sympathetic and practical interest that is being shown by employers—which sometimes is suspected of extending to the field of philanthropy—but also to the intelligent and earnest effort of the trainees themselves. There is no doubt that these people know what they want; can recognize an opportunity when they see it and are not feeling that the idea of receiving is some vague "right" or philanthropic charitable gesture. All they need is sound advice, practical help and appropriate opportunities and they will do the rest themselves. The training in all three Services during this war stressed the development of initiative and that is exactly the trait which is exhibiting itself to-day in the work of the trainees trying to get back to permanent gainful occupation. There are, of course, types in conflict just as there are differences in occupations and it is not reasonable to expect complete ability to make the right decision from people whose whole existence has been so thoroughly disturbed and disoriented by the experience of the worst war the world has ever seen. It is not always reliable to assume that the decision a man may make overseas will hold good when he returns to Canada. He sometimes forgets that he is not the same person who left Canada, any more than Canada is the same as when he left; but what he may be assured of is that there is provided on his behalf a machine to help his thinking and to present appropriate opportunities for his choice.

In Summary:

1. The objective is to put back what a service person has lost through service, not to start afresh except where obligatory, and not to add high qualifications to an already competent person.
2. To provide, supervise and ensure quality of training for the above purpose.
3. To weld the right-thinking employers into a team that will give the ex-Service people the best chance to prove themselves.
4. To influence where possible trade labour organizations to recognize the worth of ex-Service people and their proper place in society.

In the matter of the welfare of the ex-Service people the Department of Veterans' Affairs is the controlling authority; in regard to training Canadian Vocational Training is the implementing authority, and in the matter of plain co-operative sportsmanship, without which Henry James has said, "There can be no Democracy," the responsibility rests on you and associations like yours throughout the whole industrial machine of Canada.

GLENN W. FILES

Glenn W. Files, director of the Technical Service Department of General Electric X-Ray Corp.* since 1934, and a member of the firm for 26 years, died at the Alexian Brothers Hospital, Chicago, on September 11 at the age of 48, following a heart attack. He resided at 2117—78th Ave., Elmwood Park, Ill.

Born January 17, 1897, in Winfield, Kas., Files began x-ray work as a technician for a physician in that community, later meeting and working with Dr. E. C. Jerman there. In World War I, he was an Army sergeant, serving in France as an x-ray instructor and technician.

Files joined Victor X-Ray Corp., predecessor of G-E X-Ray Corp., August 26, 1919, as an instructor under Dr. Jerman, director of the Education Department, and became director following Dr. Jerman's retirement.

*Affiliate of Victor X-Ray Corp. of Canada, Ltd.

Widely acclaimed by the medical profession for his contributions to the development of x-ray technique and instructional methods, Files was the editor of the well-known book, "Modern Radiographic Technique," published in 1943, of which 15,000 copies have been distributed. Files was editor-in-chief of X-Ray Studies III, published in 1935, and assisted in the publication of Modern X-Ray Technique in 1928, and X-Ray Studies and Advanced Radiographic Technique in 1931, edited by Dr. Jerman.

In addition, Files also wrote numerous articles for The X-Ray Technician and The American Journal of Roentgenology, and for a time contributed a column on X-Ray Technique to Victor News.

He was a member of the G-E X-Ray Quarter Century Club; a member of the American Society of X-Ray Technicians, which he helped found; a member of the G-E X-Ray Post of the American Legion; and belonged to the Lakeview Lodge of A.F. and A.M.

He is survived by his wife, Alison, and by a brother, Lennis, of San Francisco.

Dominion Examination Results

DOMINION EXAMINATION RESULTS SPRING, 1945

The following candidates have successfully passed the Examinations of the Canadian Society of Radiological Technicians and have now become active members of this Society:

ALBERTA—Sgt. J. Beatty, G. Gall, Mrs. E. G. Yerex.

BRITISH COLUMBIA—M. Gates, E. Miller, C. A. Picken, J. C. Saunders, V. Stewart.

MANITOBA—A. Bessette, Catharine Foy, Opal Mitchell, Minnie Steski.

NOVA SCOTIA—Sister Edmund Compion, H. Mattenson, Reg. Pearson, Austin Singers.

ONTARIO—Amy M. Adams, M. E. Ong, C. Wood.

QUEBEC—As this province submitted numbers instead of the names of the candidates, persons represented by the following numbers have successfully passed: 205, 214, 220.

SASKATCHEWAN—G. McDougall.

OVERSEAS—The following candidates overseas have been successful in passing the examinations of the Canadian Society of Radiological Technicians: Corporal J. W. Gibson, Corporal A. H. Doyle, Corporal R. A. Blackman, J. E. Bateman.

News Items from the Provinces

NEW BRUNSWICK SOCIETY OF X-RAY TECHNICIANS

SIXTH ANNUAL MEETING

The Sixth Annual Meeting of the New Brunswick Society of X-Ray Technicians was held at the Brunswick Hotel, Moncton, N.B., on Saturday, June 25th, 1945. The President, Miss Handrahan, was in the chair and the meeting was called to order at 3.45 p.m.

Dr. A. S. Kirkland, Roentgenologist of the Saint John General Hospital, gave the opening address, "Cancer Therapy," and emphasized the importance of the technician and her attitude to the patient. On behalf of those present, Sergt. McQueen, technician at the R.C.A.F. station, Moncton, thanked Dr. Kirkland for his very interesting address.

In the absence of Miss MacNabb, Miss Howe was appointed secretary of the meeting. The minutes of the last Annual Meeting were read and adopted. The financial report was read.

In reference to The Focal Spot, Dr. Kirkland urged the members to send items to the Sub-Editor of the Journal.

A report of the Annual Meeting of the Canadian Society of Radiological Technicians was presented by the delegate to the meeting, Miss Handrahan, and a discussion followed

Re pooling of the expenses to send provincial delegates to the Annual Meeting of the Canadian Society of Radiological Technicians, it was the opinion of the members present at this meeting that small member societies should not have to contribute as much as larger member societies.

A recommendation re technicians' vacations was drawn up and Dr. Kirkland suggested that a copy be sent to The Maritime Hospital Association.

The Election of Officers was held with nominations from the floor and the following were elected: President, Miss Margaret

Grant, St. John General Hospital; Vice-President, Miss Katherine Creelman, Moncton City Hospital; Secretary Treasurer, Sister Marie de Lourdes, St. Joseph's Hospital, St. John; Executive: 1st Member, Sister De Lellis; 2nd Member, Miss Catherine Handrahan.

A dinner was held at the hotel for the members and guests present. The guest speaker of the evening, Dr. H. R. Ripley, Roentgenologist of the Moncton City Hospital, gave a very instructive address on Pelvimetry. Dr. Kirkland extended to the speaker the thanks of the meeting.

The members expressed their regrets that, through ill health, both Dr. Petrie and Miss MacNabb were unable to attend the meeting.

The meeting adjourned at 10.30 p.m.

A regular meeting of the New Brunswick Society of X-Ray Technician was held at the Saint John General Hospital, Saint John, N.B., at eight o'clock on September 21st, 1945. The President, Miss Margaret Grant, was in the chair.

After a short business sesion Mr. Kenneth Hall gave a lecture on the Four Prime Factors and showed films to demonstrate just what effect each factor has on an x-ray film. Students, as well as older members, found his talk most instructive and the thanks of those present was extended to Mr. Hall.

Miss Catherine Handrahan has taken a new position in Prince Edward Island and our Society wishes her the best of success in her new duties.

Miss Ethel F. McCracken has completed her course of study in x-ray technique at St. Joseph's Hospital, Saint John, N.B.,, under Dr. E. A. Petrie who is Radiologist there. She will replace Miss Handrahan in the x-ray department of the Provincial Hospital, Fairville, N.B.

J. RUSSELL MORSE, R.T.
Sub-Editor.

ONTARIO SOCIETY OF RADIOGRAPHERS

A semi-annual meeting of the Ontario Society of Radiographers was held in the Library of the Royal York Hotel, Toronto, on September 29th. The ballots were counted and the new officers are as follows: President, Mr. Wm. Osborne, succeeding Mr. Walter Roberts of Hamilton; President-elect, Mr. Hugh Menagh, Toronto; Vice-President, Miss Anne Hayward, Hamilton; Secretary, Mr. Paul Frederick, Toronto, and, we hope, Miss Cave, Toronto, will continue as Treasurer.

In the afternoon Mr. R. Williams of the Belleville General Hospital gave a most instructive paper on "Films of Unnusual Interest," which was amply illustrated with many radiographs, all of excellent quality and of unusual conditions. Anyone who missed this meeting missed a really worthwhile paper. Mr. Hugh Menagh of Toronto gave a talk on the radiographic requirements in the "Insertion of a Smith-Petersen Pin," demonstrated with films and equipment. A very interesting Round Table Discussion followed. The meeting concluded with a dinner and floor show. All had a good time and many comments were heard that we should have more such meetings.

The Executive wishes to draw the attention to those concerned to the following: Student technicians applying for membership in the Ontario Society of Radiographers must present at least a junior matriculation certificate when making application.

The Registrar, Mr. Hugh Menagh, has a limited number of O.S.R. lapel pins still in hand. These can be obtained for a dollar each by writing to him at 67 College St., Toronto.

SASKATCHEWAN SOCIETY OF X-RAY TECHNICIANS

I regret that at the time of going to press I have received no definite dates of the monthly meetings which it is proposed to hold during the winter months. However, members will be notified of these by mail.

The Annual Meeting of the Saskatchewan Society will be held in Saskatoon in the early Spring. Date will be announced later. At this meeting the new officers will be elected.

We are glad to welcome several ex-service technicians who have returned to their civil duties.

S. G. JOHNSON,
Sub-Editor.

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